THE

ELECTRICAL REVIEW.

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THERMAL EFFICIENCIES IN THE BOILER HOUSE.

As our readers well remember, we have from time to time expressed ourselves strongly concerning claims for very high boiler efficiencies. We do not doubt that these are put forward in perfectly good faith. For instance, the authors of a paper on "Boiler-house Economy" (of which we print an abstract on another page) state that, "working in connection with an economiser, a good type of mechanical stoker, and a superheater, as much as 85 per cent. can be utilised." Regarded critically, these words do not categorically state that the thermal efficiency of the boiler might be 85 per cent., but we presume such to be the authors' implied meaning.

We are open to conviction that such a figure is possible, but, until we are convinced, we are very dubious of the accuracy of such a statement. Mere comparisons of the calorific value of the fuel (taken by a selected calorimeter) with the weight of water fed into the boiler in a given period are not all that is necessary to carry conviction to the engineer. The model boiler test for our purpose is that embodied in a report of the Committee of the Institution of Civil Engineers on the "Thermal Efficiency of Steam Engines," which report was adopted on April 26th, 1898. This report contains a test of the Leavitt Pumping Engine at Louisville. The thermal balance-sheet of the steam-raising plant works out as follows:—

Starting at the fire-grate, it is shown that 183,600 Br.Th.U. are produced per minute by the combustion of the coal, and that 131,700 of these go direct into the water of the boiler, 10,000 are lost by boiler radiation and leakage, and the remainder, viz., 41,900, pass away with the flue gases. On the way to the economiser, 1,000 Br.Th.U. are lost by radiation, but in the economiser itself 15,750 Br.Th.U. are diverted into the feed water, 5,000 Br.Th.U. are dissipated by radiation, and, finally, 20,150 Br.Th.U. pass out of the economiser and into the chimney, and are lost to the steam plant. The heat entering the economiser with the feed-water is 5,450 Br.Th.U., which is added to the 15,750 Br.Th.U. diverted from the flue gases, thus giving a flow of 21,200 Br.Th.U. in the feed out of the economiser. Radiation, however, reduces this flow to 20,950 Br.Th.U. per minute at the entry to the boiler, where a further addition is made of 6,600 Br.Th.U. returned by the jacket water.

The steam produced by the boiler derives its heat from the furnace grates, from the economiser, and from the jacket water, and has a value of 159,250 B.TH.U. That is to say, that in this installation the combined efficiency of the boiler and economiser, deducting the jacket and hot-well returns, is just over 80 per cent.

In marine engineering, it is the last knot which counts; that is to say, the margin of power required for identical vessels to raise the speed from 24 to 25 knots is greater than that required to raise the speed from 23 to 24 knots. So, also, in thermal efficiencies, it is the last 1 or 2 per cent. which costs both money and thought. The heralds of 85 per cent. efficiencies would acclaim that the addition of a superheater would have made all the difference in the efficiency of the Leavitt pumping engine. Perhaps. All that

we ask of them is an authenticated test based on the lines of the standard referred to. In preparing it, they would have to allow for radiation from the economiser, and for the actual power required in operating the automatic stoker and in scraping the economiser. Without such deductions, talks about efficiencies of over 80 per cent. require the use of the salt cellar. While the apparent efficiency might presumably be high, the real efficiency, if one debited to the boiler the steam used in driving the accessories required to produce such a result under the most favourable conditions as to load, would be obviously much lower.

WHAT IS WRONG?

Politics in the ordinary sense must not find a place in these columns, but questions of trade, large and small, and questions of legislation and administration so far as they affect the trade of engineers, may be introduced without apology to readers of any party.

We still cherish the hope, dulled by long years of disappointment, that the Government of this country will change fundamentally.

The vast engineering interests of this country, not less the electrical trades than any other, desire a fundamental change, demand it, and must have it, to survive.

The nation will shortly decide the fiscal question at least for a few years. We must abide the issue; but all practical men are bound to examine the proposals. We will leave it to them, only asking them to consider these facts. Out of the huge total of our imports (which are sent here in exchange for exports) only 10 per cent. consists of finished manufactured goods. The remaining 90 per cent. is food for our factories and our people. The tariff can only help the manufacturer in one way—by raising the price at which he can sell. It may hinder him by making an increase of wages a necessity, and any tax on raw material comes out of his pocket. It can only raise the price of the goods he sells at home, and for that our own people pay. It does not enable him to get a higher price for the goods he sells abroad.

It raises the price at home of the whole consumption; so that, for the sake of a tax on the small volume of the foreign manufactured imports, we must also pay a tax on the huge volume of the home manufacture.

The tariff does not prevent unemployment for Germany and America, our two chief competitors. During the recent bad times the electrical trade, for instance, in Germany has suffered far worse than our trade in this country.

There is no evidence that our manufactures suffered worse in any respect than those of protected countries. On the contrary, there is abundant evidence that, under our free trade conditions, our manufacturers are feeling the advantage of better times earlier and more fully than the Germans.

A change such as the re-introduction of Protection should not be contemplated except on absolute proof that it will be for the benefit of the country at large. No man's guarantee will suffice, nor any amount of sentiment and vainglorious clap-trap about the Empire.

Is there no alternative policy?

We no more believe that there is a single remedy for all our troubles as a nation, and as engineers and manufacturers, than, we believe, that one kind of quack medicine will cure all the ills of the body.

But we know that there is a multitude of abuses, inefficiencies, faults and shortcomings in connection with our systems of Government, and of business and personal conduct, which, if remedied, would have a cumulative effect sufficient to lift the whole nation, and make life a happier thing for all the citizens of this dear old country of ours.

We do not pretend to be able to indicate a tithe of the necessary and practical steps which require to be taken, but we can indicate a few of the more pressing questions for engineers, and beg our readers' kind and indulgent consideration of the same.

What is wanted is Tariff Reform, with the word "tariff" left out. And first and foremost reform of the procedure of Government, in connection with public and private works, presses to be accomplished.

Here is a leaf that might be taken out of Germany's book, aye, and out of the book of little Switzerland, whose electrical and engineering industry is the admiration of all.

The fate of the London Power Bill last session, is an illustration of the kind of reform which is needed. The enormous initial expenses, the waste of public and private time, the final failure of the Bill, not on its merits at all (they had not come before Parliament, though recognised by the Committee) form a crowning example of the scandalous inefficiency of our Parliamentary methods.

This scheme, if ever it comes to maturity (and we are not concerned now with its merits), will be loaded from the start with water capital pumped in vain into the Houses of Parliament, and borne away on the flood of oratory which is the principal output of that august assembly.

The same procedure is responsible for millions of capital on which dividends and railway rates have to be paid for all time. Instead of Government being a facile instrument for the purposes of the country, it is a brake on the wheel of industry. No wonder there are unemployed.

We asked a Swiss engineer the other day, What is the cost of a Bill for public work—for instance, a railway in the Swiss Parliament? "Two francs fifty," was the prompt reply.

"Of course, this means only the official fee, but it ensures a prompt and thorough consideration and a definite decision on the merits of the case in a reasonable time, land being always acquired by Government valuation."

No work of the magnitude of the Simplon Tunnel has been undertaken in this country for years by any private concern, and if it were proposed that the Government should spend a similar sum of money, for instance, in buying up the derelict canals and putting them into working order, what shouts of "Impossible," "Iniquitous," "Crank," "Socialist," would resound from the talking shop for years!

And yet that is just what Holland and Belgium and Germany have done, and are doing, and most of the other countries of the world, including India and Egypt, where our money flows freely enough.

Fortunately for those outlying parts they are "The Empire."

This is merely "Little England's" ease of acquisition of land on reasonable terms; facilities of transport, no preferences to the foreigner in railway rates, encouragement of

competition in the great public services, better supervision by Government of railway management, particularly as it affects traders, enforcement of the Plimsoll Act on foreign ships entering and leaving our ports, better roads (here is work for the unemployed which would bring forth a hundred fold!), and better telephones. Surely such subjects as these, simple and ordinary as they are, are worthy of the serious attention of competent men—mere practical questions, "*a policy*," so to speak, "*of drains*,"—but in their cumulative effect of vast importance to us all. This should be our home policy; and our foreign policy—peace.

Then we should have cause to rise up and bless our Government, Liberal or Conservative, red or blue; it would matter little what it was called to the hard-working harassed men of science and industry.

Brewers and publicans say, "Our trade our policy." Professional politicians say, "Our policy our trade." Let us all as engineers ask the candidates in our divisions: "Will you make the business of this country your policy; not forgetting the interests of the Empire at large, but remembering that even the dwellers in Westminster ought to have a turn?"

Employers and Technical Education.

A REPORT has just been issued by the Association of Technical Institutes of an inquiry as to the co-operation of employers and technical institutions in the matter of technical education. The inquiry was undertaken in view of the interest excited by the reading and discussion of two papers on the co-operation of employers in the technical training of their apprentices, read at the Association last January.

In the first place, a form of inquiry was sent out to the 65 institutes affiliated to the Association, and subsequently copies of the form were sent to technical institutions and university colleges not so affiliated. In order to make the report still more complete, the inquiry was extended to some of the large employers of labour, whose educational work was not likely to be connected with the various technical institutions already approached.

Although the report cannot be said to contain a record of every example of the co-operation of employers in the technical training of their apprentices and workers, yet it contains sufficient evidence that, in a general sort of way, employers are beginning to recognise the value of technical education, and, where they do not actively assist or encourage their employés to attend technical classes, there are very few instances in which they actually discourage them. In the report before us, although we find several references which indicate indifference on the part of employers, we find only one case in which technical education is really discouraged. This reference reads, "In one town the foremen are reported as very obstructive." No further information is given about this, but it is possible that in the town referred to there is an old established firm where the foremen are somewhat fossilised men, who served their time before technical education was thought much of. Such men as these are inclined to be rather jealous of their workmen or apprentices knowing more than they do, and simply take delight in scoffing at what they would call theory. Whilst the student can put up with chaff of this kind, he is powerless to prosecute his studies if his foreman invariably finds that, on the class night some important job necessitates his working overtime. There is no doubt that with the increasing co-operation of employers who appreciate the usefulness of technical education, the foremen of the future will be men who are themselves, to some extent, technically trained, and will be, therefore, the more ready to recognise the advisability of encouraging, rather than otherwise, any studious bent in those under them.

We gather from the tone of the report that the Council of the Association attaches more importance to day courses than to evening classes, for, referring to the replies sent from institutions not affiliated to the Association, the report says "the replies were of little value," a result probably due to the fact that the inquiry was chiefly concerned with evening students. Every teacher of a technical class, however, knows that it is the evening students who are most keen on their work. The fact of a man sacrificing to technical studies time which might be devoted to some form of recreation indicates, at any rate, a desire on his part to improve his knowledge, and we think that if an accurate record could be kept of both day and evening students, it would be found that a higher percentage of successful engineers would be found to have been recruited from the ranks of evening students than from those who had passed through day courses.

Another reason for this may be found in the fact that many of the teachers of evening classes are men who are actually engaged in practical engineering work, whereas those on the regular day teaching staff really belong to the class of teachers, a class not, perhaps, in such direct contact with the practical needs of the industry.

The usual disparaging comparison is made in the report between technical education in this country, and the attitude of employers towards it, as compared with the conditions in the United States and on the Continent. In this connection, it is interesting to observe that British engineers are very frequently preferred for foreign work to the technical graduates of Continental and American institutes. Sir W. H. Preece made special reference to this point in his address at the Northampton Institute a few weeks ago on the occasion of the prize distribution. On being requested to recommend an English engineer to take charge of contracts, he has frequently asked the reason why English engineers were needed, in view of the claim that technical education is so very much superior abroad. The reason given is that the technical education abroad is really too thorough, and, to some extent, destroys a man's initiative and self-reliance. These qualities Sir William put down to our national games, such as cricket and football, in which each man has, to some extent, to act for himself, although nominally under the direction of a captain; but, whatever may be the cause, it is to be hoped that British manufacturers and heads of technical institutes will not lose sight of the fact, and by over training our rising generation, cause the atrophy of these qualities, without which technical knowledge is heavily handicapped.

There is a great deal of useful information in the report as to the trade and technical classes held in a large number of Colleges and Institutes, and of the nature and amount of co-operation on the part of local employers. Without such co-operation and encouragement, technical education is, to a very large extent, absolute waste of time and money. Employers will no doubt co-operate if the right kind of teaching is given; and, on the other hand, the technical institutes will be equally ready to give this, if the employers will say what they want, and afford the necessary facilities to their employés, to which we may have occasion to refer later.

D.

THE PRESERVATION OF HANGER BOLTS ON ELECTRIC TRAMWAYS.

By ROBERT N. TWEEDY.

For years I have been puzzled by the failure of insulated hanger bolts, and have tried many different kinds in an endeavour to overcome the trouble, which is most serious. Almost invariably the failure seemed to start at the lower end of the bolt by the gradual formation of a nodular growth at the junction of the metal and insulation, and the swelling and splitting of the insulation due to the increased bulk of the oxide which formed on the skin of the bolt beneath.

This symptom is common to all lines with which I am acquainted.

It was noticeable that failures took place on those bolts on which the growth was worst.

I put this deterioration down to the effect of the atmosphere in a manufacturing district, and in that I seem to have been at one with all who have experienced the same trouble. I considered it inevitable, and gave the linemen orders to scrape and clean thoroughly every bolt on the 20 odd miles of route. This scraping had to be done periodically, and it was found to reduce the hanger failures, but it took up a lot of the linemen's time, and was an expensive business, besides involving a continual, though small, depreciation of the insulation at every scraping.

On some systems the expense incurred in combating this trouble is even greater, for practically two sets of bolts are kept, one set being replaced at short fixed intervals by the other, which has been cleaned in the meantime.

This scraping went on for a long time, and might have continued to this day if it had not been found that the root of the trouble is not the atmosphere at all, *but the trolley wheels*. This became absolutely obvious when the action of the trolley wheels was watched during rain, and everyone will see for himself, now that it is mentioned, that this must be so.

Briefly, the deposition of conducting and foreign matter, and the formation of oxides, are all due to the moisture which is thrown into the hanger as a trolley wheel passes under it.

Remove a hanger from the line, and you will see that the interior is coated with the same nodular formation as you have observed on the insulating bolt, but it does not have the effect there that it has on the bolt.

Get an intelligent lineman to watch a hanger under which trolley wheels are passing on a wet day, and he will report that water—loaded, of course, with greasy particles of brass and copper dust—is thrown into it every time a wheel passes.

When once the surface of the bolt is damp, the dust suspended in the air will settle on it, and the action continues until failure occurs.

Having found the root of the disease, no great effort of inventive genius was required to supply the cure, which, in this case, acts by prevention.

It is necessary only to interpose a shield of some material between the trolley wheels and the bolt, and I do this by stamping out an annular disk from hard or flexible fibre, rubber, dermatine, or even a metal sheet, which I thread over the end of the hanger bolt, and retain in position by clamping it between the top of the lug of the ear and the underside of the hanger bolt, or by other suitable means which will vary according to circumstance.

The disk may be made of any diameter, but it is best, probably, to cut it a little less than the inside diameter of the hanger at the rim of the petticoat.

This disk effectually prevents the throwing of water or anything else into the hanger, and, moreover, it has the valuable quality of preventing the deposition of suspended or wind-swept dust on the surface of the bolt.

There is nothing to prevent the disk being made sufficiently flexible to be sprung downwards in order that the interior of the hanger and the bolt itself may be inspected, but the great advantage of it is that this inspection is rendered unnecessary, and the usual flash test (*vide* my article on the "Prevention of Overhead Accidents" in the Electrical Review, for August 11th, 1905) will reveal a failure of the primary or secondary insulation before trouble can arise, and before any sign can be detected by visual inspection.

I satisfied myself by the following tests that it is this nodular formation which gradually lessens the value of the insulation, and finally supplies a path along which a quickly increasing leak can pass. If, therefore, this formation can be arrested the insulation will last as long as the hanger itself, other things being equal.

Of course nothing will protect the user against insulators which are defective in composition or manufacture.

Tests Referred to above.

The insulation resistance of an overhead hanger was tested under various conditions to show what may be expected from the use of the hanger shield as a means of protecting the bolt from the effects of water carrying metallic dust, &c., thrown off the trolley wheels of passing cars.

1. *New bolt in hanger.*

	Insulation Resistance.
(*a*) Dry	Infinity
(*b*) Wet*	Infinity

* This bolt did not remain wet in reality, as the water ran off the new surface just as if it were covered with an oily film.

2. *Old bolt in old hanger*, as removed from the line without selection :—

(*a*) Dry	2,267 megohms
(*b*) Wet	·005 megohm
(*c*) Bolt scraped clean and moisture removed by wiping only	330 megohms
(*d*) Bolt in same condition as (*c*) but dried by stoving for 44 hours at 160° F. ...	Infinity
(*e*) Bolt in same condition as (*c*), but tested after being dipped in water and not dried	5·32 megohms

These tests show conclusively :—

1. That an insulating bolt which can be kept in a new state, with the original shiny surface off which water runs at once, will never break down, and the nearer that condition can be approached, or the longer it can be maintained, the less chance there is of failure.

2. That an insulating bolt which has been in use under ordinary conditions—*i.e.*, exposed to the action of water, &c., thrown off the trolley wheels—although a fairly good insulator when dry, has its essential quality reduced to the point of breakdown when wet.

3. That the removal (by scraping or other means) of the deposit and oxide at once returns the bolt to its original condition of perfect insulation when dry, and that when thoroughly wet the insulation resistance is still well above breaking-down point—some 1,000 times better, in fact, than the unscraped bolt.

4. That if periodical scraping and continuous depreciation of the insulating bolts is to be avoided, the only thing to do is to prevent the access of moisture and of foreign conducting and corrosive material.

Compared to the economy in all directions which is obtained by the use of the simple shield of which I have written above, the cost of the shield is absurdly small. Patent rights are in course of being granted, for although the remedy is so simple, the disease has been running its disastrous course unchecked, or checked only by expensive means, for as many years as the insulated hanger bolt has been in use, and it is only right that the monetary recognition which may be gained by a monopoly should be given to anyone who finds the cure, howsoever simple it may be.

ELECTROMOBILES.

By HENRY F. JOEL, A.M.I.C.E.

In an article contributed to the *Electrical World and Engineer*, of New York, October 21st, 1905, by Mr. Frank B. Rae, on "Speed-Time Curves for Automobile Motors," some most astonishing conditions and results are given, which, taken seriously, would undoubtedly mislead any readers who might not be well informed as to the modern

practice of electric traction and of electromobiles. The paper is a most laudable attempt to add to the knowledge of this highly interesting subject, and it deals with and gives elaborate calculations and curves affecting the special question of the influence of stoppages on the total running output of the battery.

Mr. Rae starts with two defects "that must be acknowledged in electrically propelled vehicles; the distance they will travel is not great enough for many requirements, and the cost of maintaining the storage battery is very high for the mileage obtained."

In calculating the power required to start and run a truck of 9 tons (truck 4 tons, load 5 tons) on fair condition of road, asphalt, macadam or good block pavement, in about equal proportions, or the average roadway that the electrical vehicle encounters in ordinary operation in city streets. Mr. Rae assumes the extremely low draw-bar pull or tractive resistance of 30 lb. per ton, and he calculates that two electric motors giving together 4·8 H.P. would be sufficient to run this truck, whereas experience has shown that for such a road and load it would be at least 60 lb. per ton, and most probably would average 100 to 120 lb. per ton, whilst the power required of the motors, taking the efficiency of the whole truck at 50 per cent., and allowing for the increased power required for the starting effort, hill-climbing and other conditions, would be from 18 to 40 H.P.

Mr. Rae is careful to point out at the end of his article that the 30 lb. taken is evidently too low for average conditions, but he nullifies this by stating that the builders allow ample margin in the motors and controlling system to take an increase up to 50 lb. per ton or over; his whole article, with calculations, curves, and results, is unfortunately based upon these false premises and is therefore erroneous, and the conditions given for the power required and results obtained are absurd.

Mr. Rae takes a battery of 44 cells with 19 plates each, giving 90 volts and having a capacity of 63 amperes for four hours, which must be taken as the maximum rate permissible —the weight of this battery probably being about 16 cwt.— and he drives his car of 9 tons, accelerating in four stages at nearly 1½ ft. per second per second with this battery up to six miles per hour within eight seconds, a dangerous acceleration with such a load on common and public roads. To do this he provides two 2·4-H.P. electric motors running at 800 revolutions per minute.

As to the tractive resistance on the level, in lb. per ton, authorities differ considerably:—

Dupuit, in 1837,	gave	66	lb. per ton	for good	macadam.
Telford and Babbage	„	70	„	„	„
Michelin, with iron tires	„	60	„	„	„
U.S. Agricultural Bureau	„	45	„	„	„

The Society of Arts, London, in 1875, experimenting with an omnibus weighing 2·57 tons, at 3½ miles per hour, found the tractive resistance with—

Granite	17·41	lb. per ton.
Asphalt	27·14	„
Wood	41·6	„
Good macadam ...	44 to 48	„
Granite macadam	101	„

The state of the roads, tires and bearings, all affect the question, and inclines or variations of road, such as would be met with in towns, raise the above figures to double or more, and 60 lb. per ton would be a reasonable average.

The efficiency of such small motors cannot be taken as more than 70 per cent., whilst when overloaded, with no margin in the field cores the efficiency would be much less. The loss of efficiency in the transmission gear for a truck weighing 9 tons would be at least 10 per cent., and an all-round efficiency of 50 per cent. is a fair basis.

A little consideration will show that, taking the tractive resistance at 60 lb., and an all-round efficiency of 50 per cent, the power necessary to run this truck at six miles an hour on a dead level road would be at least 17·2 H.P.: allowing for drop of E.M.F. due to the large discharge, the current taken would be about 150 amperes—the starting effort would require at least double this current or 300 amperes—and for taking an incline of, say, 1 in 20, the current required at the still further reduced E.M.F. would be over 300 amperes.

Needless to say, such a current through the 2·4-H.P. motors would burn them out, and it would irretrievably destroy the battery. The outfit of battery and the two motors would be barely sufficient for an electric landaulette weighing only 30 cwt.

On an ordinary city macadam road, a car of 9 tons, even with broad tires, would cause subsidence and sink a little into the surface of the road; the effect would be the same as running the truck up an incline, possibly of 1 in 20, and, of course, such a battery and the two small motors, even if they stood the current, would be quite unable to start the car at all.

Upon the basis of the tractive effort of 30 lb. per ton, and two motors of 2·4 H.P. each, Mr. Rae has investigated the effect of stoppages of the car upon the output of the battery, and after plotting the curves from such calculation he arrives at the following results:—

The effect of stops and of the necessary acceleration to full speed upon the "watt-hour per ton" rate, and in which the best speed possible is attained, is shown in the following table, in which the total miles that the truck will travel on one charge is determined by dividing the watt-hours per truck-mile into the total watt-hour capacity of the battery (22,680 watt-hours) as stated by the makers:—

Stops per 1,000 ft.	Average speed in m.p.h.	Watt-hours per ton-mile.	Total miles on one charge.
0	7·8	71·8	35
1	7·1	78	32·2
2	6·5	85	29·7
3	5·9	91·7	27·5
4	5·7	96	26·4

These figures, as I have shown, are absolutely unreliable. It is not safe to calculate the watt-hours per ton-mile on ordinary town roads with varying grades, and with this class of heavy goods vehicle, at less than 200 watt-hours per ton-mile, and the effort required for starting such a truck, allowing for subsidence in the road surface, subsidence of the axles in their bearings (known to require an increase of starting power of something over 20 per cent.) under such a load as 5 tons, as well as the road tractive resistance, would make the power actually required probably four times as much as that given; two 9·6-H.P. motors — that is, four times the 2·4 H.P. — capable of standing a 100 per cent. overload, would be required, with a battery whose output at a four-hour rate and with 90 volts only, should not be less than 240 amperes (again four times that provided), and weighing approximately 3 tons. The miles given for a run on one charge are ridiculous, assuming that the truck could run at all with the power outfit provided; it has been shown that probably the whole available current in the battery, taking it at 200 ampere-hours at a one-hour rate, would be used up in less than one hour, giving less than six miles in place of the 26 to 35 miles given in the table of results, and, of course, the curves would require to be replotted with the proper quantities, much higher peaks, and altogether different periods of time, both in making the changes for acceleration and also for braking and coasting—*i.e.*, the whole article would have to be reconsidered and rewritten.

I would point out that electric tramcars weighing loaded about 10 tons and running on iron rails require, and are fitted with two 25 or 30-H.P. motors, of course to run at higher speeds. Petrol omnibuses, such as those used by the Great Western Railway, weighing with passengers 7 to 8 tons, require engines of 28 H.P. Lorries carrying 3 to 5 tons, running at only 6 miles per hour, are fitted with 30 to 40-H.P. engines, and experience has shown that electric goods cars with batteries of suitable size and proportionate weight would at times require to exert even as much as 40 H.P. to meet all conditions of the road at 6 miles an hour only.

Imagine an electric landaulette equipped with two 2·4 electric motors, and the same battery as described for this 9-ton truck. Such a landaulette would run about 30 to 40 miles on one charge. Now load this carriage (strengthened to take the weight) with an additional 7 tons of dead weight, and find the distance it could now run, even on a hard level road—that is, if it could possibly move at all—and we can then get some idea of the conditions given and the theoretical results obtained by Mr. Rae.

It is unfortunate that such articles as the one I criticise should be published. Had Mr. Rae confined himself simply to the academic and theoretical treatment of the subject, no one could have taken exception to it; but it goes forth as

an actual and practical basis for equipping a truck of a total weight, with load, of 9 tons, and I trust that no one will endeavour to carry it into practice.

THE ELECTRICAL FROISSART CHRONICLES.

(With some apologies to Sir John, and more to "F. C. G.")

By IBID.

IV.—Of the Battle of the Powers and the Count of London.

Now you shall hear how the Count of London, being jealous of the power of the Elektricks, was minded to enclose all their magick under his own control, and to sell the same to his subjects at such a price as pleased him. And in this he did, to my mind, very rightly; for, seeing he is Count and Prince of all that vast city, he is by nature fitted to rule, and by learning and endowments gifted to curb the passions of his subjects; and it is in no wise meet for any guild or association of persons who have not been born rich or powerful to abrogate to themselves too great share of the direction of things, howsoever wise they be.

Howbeit, I conceive the Count to be in the wrong, that he doth ever conceal himself, and is known to the people only through his Council; but doubtless so great a Prince hath a wise reason for so doing.

To this end sent he a very great force armed with Retoric and Statisticks and Arguments and the like weighty and pointed matters, to subdue the Electricks and wrest from them their magick power.

Now, I would you remark the cunning of these magicians; for they, feigning submission to the Count, assure him that his doings are in a great degree pleasing unto them, and that it is their fixed desire to advantage his purpose; and await his coming as those that watch favourably a procession (the which is a common occupation here) and would in no wise pay therefore. So that leaguer set forth from the Count his Palace, which is in the Mausoleum strete, or thereabout, hard by the place of the Great Candlestick. They came without let or hinder the space of about half-a-mile, to a part where the ground is soft, and laid out in gardens and terraces, very suited for a pleasant contemplation, and a favourite resort. Many people were here already from divers countries and climes, engaged in a peripatetical discussion. Others, again, were burning of foreign weeds, and in deep meditation upon the adverse times. And the officers appointed thereto were taking up and mending the roads.

The Count, seeing this concourse, sent to enquire of them the safest way to the stronghold of the Elektricks; and they made haste to answer that all ways leads thereto, also that many of themselves had an errand thither, and would presently proceed to compass it, and, until that might be, there would be no space for others on the same road. So the Count enquired who they were, and the names of their leaders, and to this their herald made answer: "We are the Powers that be, and the Powers that would be; and whereas the Electricks have divers holds and magazines from which to send forth their magick, we esteem it better for ourselves, and for the good order of the County, if these were collected under one head, so that their jealousies and dissensions may be quieted and cease; for, at the present, the magick we have from one division will by no means fit the place prepared for it in another, though they be in the same strete, and the geniuses which are in the houses of magic groan dismally from overwork, to the terror of all worthy dames thereabout; and, moreover, if all the magick be gathered under one jurisdiction and head, for one maravedi shall ye propitiate the devil which is in the slot-meter, where now he is barely content with six. Wherefore we are minded to go to the Electricks and, by the threatening of them with our Bills and other hedging implements, to compel them to allow us this supply of Power, or Power of supply." In this they were all agreed, and so murmured approvingly; but when one would have proposed a site for the great principal workshop, as on the shady slopes of Wandlesworth, the lofty steppes of Stepney, the breezy banks of Greenwich, or the sunny isles of Chesil, or even the woods thereof, there arose such babel and clamour that it seemed that not two were of the same mind.

Now, when the Count heard this, he took long counsel with himself, meditating; and I doubt not it seemed to him a good thing for all these people and countries to make war on the Electricks first, and for him to follow them after a seemly space; for, by this means, both the Electricks would become weary with much fighting, and, their magick in the fight becoming apparent, he would know better the means to cope therewith; truly a very sagacious Prince.

(It has been told me that the Electricks can at will squirt upon the foe from a pipe, water mixed with a very strong Electrick fluid; which compound is eagerly drunk by the invaders. But he that told me this said at the same time "Bunkum"; which also hath a hidden meaning.)

While they were thus meditating, comes forth a stern knight, clad in suitable armature, and remark-worthy for that in charging he aimed very low, and did strive with his Bill to force a passage through the throng. They, leaving their own dissension, hang about his path, and press him on all sides, so that his progress is very slow. Nevertheless, by perseverance, and the support of those who were won over by his courtly bearing, he won through them to the other side of their camp.

Alas! how many broken Bills were left behind in the melly! And, I suppose, some sore heads also.

Now, when this good knight had won a way through the Press (which was oft hard upon him), and, with those on his side, was coming near to gain his object (his Bill yet in his hand, unscathed save for a few nicks and scratches, and still serviceable) he findeth before him a fenced road very fair to see, and which certain persons of solemn mien are continuously mending. So was he compelled to pick his way carefully thereby, often waiting till the stones of the road were suitably placed, watered, mudded and rolled. Meanwhile, the sun is become high in the heavens.

Presently a cheerful sound is heard amongst the workers; and, collecting their coats and implements, they fetched a board whereon was written, "Road stopped," and placed it in the path of the approaching company, departing with many agreeable expressions of pleasure. The advancing company, when they saw this, were very greatly cast down; for they knew that it is contrary to Precedent to pass such a board, also that it was now dinner-time.

And some asked how long should this resting last, and were told, "We have no official information."

So they returned all to their homes. Now, ye will say, this is no battle of the Count of London?

In that I know nothing, for some say the knight who fought so well is called the Administrative Count, so herein I am not sure; others, that he is called Progress, and will come again in some other form; while others yet call him the Giant Monopoly. In whatsoever form he appeareth, I trow there will be a great bill for road-mending.

THE MANAGEMENT OF SMALL CENTRAL STATIONS.

By HENRY JOSEPH.

Almost ever since electricity has been supplied from central generating stations the efforts of central station engineers have been directed towards the attainment of a high load factor as an element in the cheapening of the cost of production. As a means to this end every effort has been, and is being, made to increase the day load by advocating the use of motors, heating apparatus and so forth. In large towns, where the day load is sufficient to justify a day shift, there can be no doubt that this course is a wise one, and that current in such cases can very well be sold for use in the daytime at a price very considerably less than that charged for night consumption. But when we come to consider individual cases of small towns or villages, where, either from their purely residential character or their small size and limits of ultimate expansion, a large day load is out of

the question, it is quite a debatable point whether it is advisable to encourage a day load at all, especially if, in order to do so, the rates for such purposes as have been indicated are to be materially reduced.

There are, in fact, many problems in central station management which bear an entirely different aspect in a very small undertaking to what they do in a large or moderately large one. What is true for a fair-sized but growing town with an industrial population is not by any means necessarily correct for a small town of under 10,000 inhabitants with a residential population, and no apparent prospects of any very rapid expansion. In such a case it is very unlikely that the day load will for many years be sufficient to economically load the smallest set ; and, consequently, the current used in the daytime has to be supplied from a battery, which practically means an extra loss from charge to discharge of 25 per cent., or a loss equal to $33\frac{1}{3}$ per cent. of the units sold. Probably little or no labour is entailed in the generation of these extra units, so the extra cost is not quite as great as it would at first sight appear, but under these conditions it does not seem to be commercially sound to sell current in the day time at a reduced price. In an alternating station this argument does not of course apply (unless a motor-alternator is combined with a battery), and in this case the day load, though more difficult to obtain, is essential to anything like economical running. There are, of course, many continuous current stations of small size that have for years been trying to increase their day load by means of cheap rates, but few indeed of the really small ones have started a day shift. So long as there is an ultimate prospect of this being attained, it is perfectly justifiable to hasten matters by reducing the power rates even if for the first few years the result is not remunerative. But where from the very nature of things the day load must ever bear a very small proportion to the evening load, it appears to be the best policy to look facts in the face and charge a uniform rate for light and power.

In one or two small towns where no appreciable day load is anticipated, a small oil or gas-driven set of from 4 to 10 H.P. is installed in place of a battery, so as to save the capital cost as well as the heavy depreciation of the latter. This system although inefficient certainly recommends itself, as it does not entail stand-by losses or the cost of attendance.

There is a tendency with central station engineers, as with people in nearly every branch of industry, to follow one another like a flock of sheep. Once a certain lead has been given by one man and adopted by a few others, the rest follow as a matter of course without appearing to consider whether their case is similar to those of the few pioneers, and so electricity supply schemes come to be carried out on stereotyped lines, as if the system which is applicable to Liverpool were equally suitable in all its details to Muggleton-on-the-Mud.

A good example of this kind of thing is the adoption of the maximum demand system. One man comes along with a demand indicator in the hope that he will flatten out the peak of his load, and also with the conscientious desire to charge his various consumers in proportion to the cost of supplying them.

The system, no doubt perfect in theory, impresses itself on other engineers, and is finally adopted by stations all over the country, in many of which the capital cost and clerical work involved are probably out of all proportion to the advantages ever likely to result from its adoption. The maximum demand system is a bad one inasmuch as the average consumer can never be brought to understand its working, and many fight shy of adopting electric light for fear they should be charged at the higher rate. Indeed, everything points to it being finally superseded by a flat rate with a sliding scale favouring large consumers.

The system of charging at a reduced rate for heating and power purposes irrespective of the hour at which the demand is made, also seems to be unsound, and the case is being met in some places by the use of double tariff meters controlled by time switches. This system seems to be very sound in theory, but it remains to be proved whether the extra capital cost is justified by the advantages gained. One of these is the tendency to prevent the overlapping of the lighting and power loads. If this were its only merit the system would certainly not pay for itself, but it also has one very great point in its favour.

If the cheaper rate is sufficiently low, the consumer can very well afford to be extravagant in his daylight consumption, and will not hesitate to make what use he can of his supply as long as the meter is only registering cheap units. Hence it encourages the use of apparatus which otherwise would not be used at all, and what most of all is needed in a station of moderate size, it results in a long-hour day load.

A long-hour demand at any time is, of course, much to be desired whether in the daytime, or in the evening or night, and for this reason street lighting is a most valuable asset both for large and small stations. In small towns it is not usual to keep the public lamps alight after midnight, hence this load will mostly be supplied direct from the generators.

The selection of a suitable consumers' meter is a problem that requires very careful consideration. It is difficult to find a meter which, while cheap, is also accurate and reliable. There is a very considerable difference between the cost of the cheapest and the most expensive meter, and this difference in the aggregate represents a capital expenditure which cannot be treated lightly. Are the advantages of the expensive meters sufficient to justify this extra cost ? The principal advantages which one expects to find are : (1) Accuracy, or, in other words, the assurance that the consumer will not be paying for less current than he consumes ; (2) Reliability, freedom from breakdown with its resultant necessity for more or less frequent replacements and repairs ; (3) Low consumption of energy ; (4) Low starting current. Only careful trials of different meters can settle the question at issue. One of the faults which most motor meters develop is a tendency to run slow after they have been in use for a considerable time, and this defect, which is likely to result in a very considerable loss, is one that is by no means restricted to the cheaper variety. There are meters on the market which show the reading in units direct, thus preventing the possibility of error on the part of the inspector. Confusion is very liable to arise in reading the old-fashioned dial meters, and it seems a pity that the former system is not universally adopted. It really seems as if a meter which is fairly accurate and not too liable to be upset by careless handling is, after all, what is most needed, especially on small systems where most of the consumers are small ones. And if such a meter can be obtained at a price considerably lower than that of one of greater accuracy and lower energy consumption, the saving is in most cases justifiable. The other extreme has, of course, to be guarded against, for a meter, though low in first cost, may entail an amount of labour in replacing, overhauling, and re-testing that will make it the dearest in the long run.

In most small towns a good deal of attention is given to the prepayment system. It is usual to wire small houses up to 10 or 12 lights free of charge, the slot meter being arranged so as to charge the consumer about 25 per cent. more than the ordinary rate, in lieu of paying for the hire of the meter and installation. This system has in many places been fairly successful, but things have to be cut very fine all the same to make it pay, and the cost of the meter is often nearly as much as that of the installation. Most prepayment meters are very liable to get out of order either through careless use or bent coins being used, or through some inherent defect in an over-complicated mechanism. A really good and reliable slot meter at a reasonably low figure has yet to be found.

If all the costs incurred in connection with a pre-payment system were properly allocated, very few towns, in the opinion of the writer, could show much of a margin on this class of consumer. Frequent attention is necessary either from defects in the meters, or from those sudden and unaccountable, and altogether too frequent changes of tenancy which seem inseparable from the poorest class of consumer. One of the advantages of the pre-payment system is that the clerical costs are reduced to a minimum, and if special efforts were made to lower the capital charges, there is no reason why there should not be a considerable profit on slot consumers in spite of the inherent disadvantages already referred to. One essential is the reduction of mains costs by putting a block of cottages on one service. If every house is to have

a separate service, especially if this entails a road crossing, the system cannot be expected to pay. The writer puts a service in the centre of a block of from four to six cottages, and loops from cut-out to cut-out on the bus-bar system by means of interior wiring, the wires passing through the party walls in insulated tubes. One objection to such a plan is that the fuse may blow in the service cut-out, when the tenant in whose house it is fixed is away for a long holiday with the key in his pocket. This possibility is somewhat remote, especially if good heavy service fuses are used, but it would certainly place the supply authority in a very awkward position if the other five houses had to wait for their light until the holiday-maker had returned, or the key of the house had been obtained. This possibility could be removed by fusing the block in a cheap inspection box just outside the centre house, but the probability is that liberal compensation in such an eventuality would be cheaper than taking elaborate, and perhaps expensive, precautions to obviate it. Some engineers, who are wantonly extravagant in services for small consumers, choke off many really good ones by making a charge for all cable laid over and above the 60 ft. limit. Except in extreme cases, it is the greatest folly to make this charge, for, although the particular consumer may not object to pay, it has a very serious deterrent effect on others who are contemplating taking a supply. Everything should be done to reduce the initial outlay of the would-be consumer to a minimum, as it is often on this ground, rather than from any fear as to the cost of current, that a man will shrink from adopting electric light.

The free-wiring system has for this reason been the means of greatly extending the business of many electricity supply undertakings. A fairly common system is to charge the consumer with a rental equivalent to 5 per cent. or 7½ per cent. on the initial outlay. If the latter figure is adopted, a sufficient return is assured to pay interest and depreciation on the installation. The wiring is either done by the company or by local contractors who, having canvassed the consumers, are given the order to wire the houses on behalf of the company. This acts as an incentive to the local firms to thoroughly canvass the district. The same plan is adopted for slot consumers. To get over the disadvantage of the heavy capital cost of slot meters, it has been suggested that small cottages should be wired free with, say, seven lights each, and supplied in blocks of half-a-dozen or more in a row, off one service. The cottagers would be charged a fixed sum varying from 6d. a week in the summer months to 1s. a week in the winter, and would be allowed to use as much current as they pleased up to a certain limit. A meter would be fixed which would show the consumption of each block, and if at any time this meter showed that wastefnl use was being made of the supply, the culprit would be localised by fixing a meter in each house. The offender would then be liable to be disconnected. Where this system has been tried, it has failed, for two reasons—firstly, the current consumption was excessive, the consumers being unnecessarily extravagant; and secondly, it produced a feeling of discontent among other consumers on the slot system, who were paying as much or more and getting less light.

The question of canvassing is one that is not always given the amount of attention it deserves. Where the undertaking is too small to pay for the services of a canvasser, the best plan is to encourage by every available means any wiring contractors that are willing to do this work, even though the result may be to bring the said contractors into competition with the company's wiring department. By the exercise of a little tact, any tendency to unpleasantness can be avoided, and it is often wise in certain cases for the company to retire and leave the field free to the contractors. It is, after all, a matter of secondary importance whether the wiring department makes a small profit or merely pays its way. By adopting the free wiring system and sub-letting the installations, a whip hand is kept over the local wiring firms, and it is possible by these means to force them to adopt certain standards laid down by the company, such as the exclusive use of lamps of two or three of the best makers, both for free wiring and cash installations. Where a canvasser is kept, or where there is a man who can be spared from his ordinary work for a few hours a week, the canvassing should be done on a systematic plan. It should be borne in mind that consumers show the same sheep-like tendencies as central station engineers, and once a start has been made in a particular road, it is often a comparatively easy matter to induce others in the same neighbourhood to take a supply. Three consumers, each paying £10 per year for current are better than one consumer paying £20; hence it is the best policy to so arrange the installations as to reduce as far as possible the current consumption of every consumer. It is only by so doing that the gas companies can be successfully competed against. Therefore, current-saving lamps, such as Nernst, tantalum lamps, &c., should be advocated, and care should be taken that 16-c.p. lamps are not installed where 8 c.p. would be sufficient. If a room is sufficiently illuminated by three 8-c.p. lamps the extra illumination of three 16's is not only wasted, but is not appreciated. The writer has often traced complaints of excessive consumption to the reckless use of unnecessarily high candle-power lamps. Such complaints do an amount of damage to the company which is out of all proportion to the value of the extra current sold. Complaints should not be treated lightly, but a responsible person should be detailed to inquire into their cause and suggest remedies.

In conclusion, the writer would urge the necessity of keeping all capital costs as low as possible on small systems. Large systems with numbers of big consumers packed close together all along their mains can afford to adopt extravagant means to safeguard the supply and maintain a steady pressure, and many fads can be indulged in inside the station to facilitate the working of the system, but in small undertakings, with mostly small consumers more or less scattered about, it is necessary to do everything in the cheapest possible manner consistent with economy and sound engineering.

The writer looks forward to the time when overhead wires will be more generally used for supplying scattered districts, thus rendering a cheap supply possible where it is now prevented by the prohibitive cost of underground mains.

CORRESPONDENCE.

Letters received after first post on Wednesday morning cannot appear until the following week. Correspondents should forward their communications at the earliest possible moment. No letter can be published unless we have the writer's name and address in our possession.

Cash on Delivery.

In connection with an advertisement in your column of "Articles Wanted," I recently experienced a little difficulty, which, if briefly related to your readers, may prove useful to them, by impressing on them the necessity for extreme caution in arranging first transactions with even old-established firms.

Having a motor-fan for disposal fulfilling the advertised requirements, I wrote in, quoting a low price—£4 10s.—and stipulating prompt cash. A week later (September 1st) a stranger called at my house, in my absence, examined the article, and retired, leaving no name. On September 4th he called again while I was out, and left a written offer of £4 in the name of his firm.

On receipt of this I promptly signified my acceptance, by telephone, agreeing to deliver to bearer of the firm's written order, and insisting on cash remittance as soon as goods should have been checked in at warehouse.

On September 5th, as arranged, their man took away the fan. With it I sent a letter of advice requesting early remittance.

On September 6th the firm sent me, instead of the promised cheque, the following eye-opener:—"We shall have to return the fan owing to *our customer* having bought one from elsewhere without our knowledge." Naturally, I declined to be introduced to *their* customer after I had completed *my* part of the transaction, and on September 7th I wrote saying so.

On September 12th the firm sent me a letter informing me (1) that as soon as they *saw* the thing (on 5th idem) they knew at once it would not suit; (2) that they nevertheless offered it to *their* customer, only to find he had ordered elsewhere; (3) that their assistant had instructions to make a *conditional* offer only; (4) that, if it *had* suited they

would have immediately sent a cheque; (5) that I could hardly expect them to keep it, &c.

On September 13th I wrote stating fully my view of the matter and offering in default of prompt settlement to submit the matter to arbitration (at Westminster County Court). No notice was taken of that letter. I spoke to the managing director by telephone on September 21st. He said he would see what could be done, but as he had not decided on September 26th what could be done, I on that day entered a plaint at the County Court (hearing fixed for November 9th).

On November 1st the amount was paid into Court—with costs. These facts show that, even in Victoria Street, there are firms who have vague ideas of the real meaning of the expression "prompt cash."

Neophyte.

Prepayment Meters.

With the services of the rate collectors placed at their disposal, and an overflowing municipal exchequer to draw upon, the engineers of wealthy cities have little recourse to prepayment meters. But companies operating in small, poor towns, have to sell energy in spoonfuls to many a consumer with an unsettled income, barely sufficient to provide the necessaries of life. A good, reliable, prepayment meter would be a great help in dealing with such consumers. The alternating current ones give disappointing results, the switching mechanism being very erratic, and the methods used for sealing the cases being open to adverse criticism. Besides, the general design of the instruments is not conducive to long life, so that they cannot be considered, with their extra cost, as warranted to prove good investments.

Perhaps some engineer has found an alternating current meter that has stood the test of time; if so, some particulars of their performance would be welcome.

Manager.

Wear of Overhead Wires.

I can corroborate the statement made by two of your correspondents, namely, that the wear of overhead trolley wires is largely due to arcing. With deep-grooved ears, or, indeed, any ear round circular wire, wear takes place mostly at the tips, where the point of contact changes its diameter, that is, from small diameter when running on wire to large when touching ear tip; and from large diameter on ear, dropping to small diameter on wire. At both these points slight arcing takes place. At the facing tip the arc is from *wire* to wheel, and at the trailing tip arcing is from *ear* to wheel. This is the reason that when a trolley wire breaks it is almost invariably fractured at the facing and not at the trailing end of the ear, the continuous arcing on the wire at this point making the metal short.

I also agree with the statement that the wear on wire is just as great with flexible suspension as with rigid, and in the middle of a span as at so rigid a place as a low bridge; but I do not think much reliance can be placed on micrometer measurements, as the wear is not circumferential at all; unless a section is cut and measured with a planimeter, the eye is the surest guide. It must be borne in mind that with flexible suspension less arcing and hammering takes place, and consequently falling wires are less frequent.

A. J. B.

Flame Arc Lamps.

In your issue of December 22nd you quote some figures given by Mr. Alger, and I should like, seeing that I took part in the meeting, and you are good enough to report part of my speech, to correct the reference to flame arc lamps.

In your issue of April 21st of this year you were good enough to make reference to the tests of the Excello arc lamps made by the Westminster Electric Testing Laboratories on March 11th, 1905. I am also aware that you took particular care to verify the methods employed in these tests, so as to be sure that the figures referring to the Excello lamp, which seemed to indicate an unprecedented efficiency, were actually credible.

In the issue in question the consumption for the Excello arc lamp, with a candle-power of about 2,300, without the globe, was given as 382 watts, which brings out the consumption in watts per candle-power as ·166—a very much superior figure of merit to that of the ·4 given in your issue of the 22nd inst.

Justus Eck.

London, *December 22nd*, 1905.

[Mr. Eck is here referring to mean hemispherical, not mean spherical, candle-power. As a luminous source absorbing about ·16 watt per candle (*mean spherical*) approaches 100 per cent. efficiency, it is necessary to bear in mind this distinction.—Eds. E.R.]

LEGAL.

Manchester Carriage and Tramways Co. *v.* Swinton and Pendlebury U.D.C.

According to the *Manchester Daily Guardian*, on the 15th inst., the House of Lords gave judgement on an appeal at the instance of the Manchester Carriage and Tramways Co. (in liquidation) in their litigation with the Swinton and Pendlebury District Council. The appeal was from an order of the Court of Appeal reversing the judgement of Mr. Justice Channell on a special case stated by an arbitrator in the matter of the purchase by the respondents of a portion of the undertaking of the appellants. The question raised by the appeal was whether the respondents were compelled to purchase with the tramway lines in their district the Church Street depôt, which was not in their district (see Electrical Review for December 9th, 1904, p. 939).

Lord Macnaghten, in delivering judgement, said the tramway was worked by the Tramways Co. in connection with lines constructed by the Salford Corporation and leased to the company. In this way it formed part of a continuous line to Manchester from the limits of the district of the Swinton Council. The purchasers of the line were required to pay the value of the adjuncts and accessories, even although these were of no value to the purchasers. The arbitrator, in an award dated May, 1903, found the value of the Church Street depôt, &c., to be £49,000, but added that should the Court be of opinion that the Council was not compelled to purchase the depôt, then two items, which amounted together to £24,317, were to be deducted and the value was to be reduced to £24,689. The Lords Justices of the Court of Appeal inferred from the variation in language that there was some ambiguity in the award, and that the arbitrator had it in his mind to submit to the Court some question of law which he certainly did not formulate, and which counsel for the Swinton Council candidly admitted that he did not ask him specifically to state. His Lordship could not guess what the question could be. Questions of user and of suitability were mere questions of fact, which had been answered by the arbitrator, and answered in favour of the Swinton Council. The only question which the arbitrator reserved—the question depending on geographical position—was determined in favour of the appellants by the Judge in the court of first instance. He moved that the order appealed from be reversed, and that the order of Mr. Justice Channell be restored.

Lord Robertson and Lord Lindley concurred.

(The decision of Mr. Justice Channell was reported in the Electrical Review for May 20th, 1904, p. 823.)

Underground Electric Railways Co. of London, Ltd., *v.* Commissioners of Inland Revenue.

In the House of Lords on 15th inst. an appeal was heard as to whether, upon the true construction of the Stamp Act, 1891, an agreement between the appellant company and the Metropolitan District Electric Traction Co. for the sale and transfer by the latter (the Traction Co.) to the appellants of their undertaking, upon certain terms, was properly chargeable with *ad valorem* duty in repect of £1,527,357, and also *ad valorem* duty as to £780,000, the consideration money. The appellants contended that the consideration money ought not to include the £780,000; the respondents, that it was properly included. Mr. Justice Channell gave judgement in favour of the appellants, but the Court of Appeal reversed his decision, and gave judgement for the respondents. Hence this appeal. Their Lordships, who heard the arguments in the case, were of opinion that the Court of Appeal was right, and dismissed the appeal.

THE POSITION OF ALUMINIUM.

The issue of fresh share capital by the Aluminium Industry Co., of Neuhausen, to which reference was made in this journal on September 29th, has taken place at a period which is very favourable to the undertaking, owing to the scarcity of supplies of aluminium in the market and the consequent increase in the price of the metal in recent weeks. At present, the price in Germany and Switzerland has advanced to 4s. per kilogramme for large pur-

chases of the first quality, or, say, £200 per ton—a quotation which was obtained only at the commencement of the electrolytic production of aluminium about 15 years ago. The competition among the various works, however, soon brought the price down to 2s. per kilogramme, but the International Convention of a few years ago was the means of increasing the price to 2s. 6d. The actual cost of production is estimated at 1s. 9½d. per kilogramme, although authentic information on the subject is not available.

An explanation of the recent sudden advance in price is not to be found in an equally sudden increase in the consumption. On the contrary, the cause is to be sought in an unexpected reduction in the capabilities of production on the part of the four works situated in France, which were subject to a strike between August 23rd and August 30th. As a consequence, the plant at the works will have to lie idle, it is said, for several months, as the baths which were in operation became "frozen in." The European market is closed to the Pittsburg Reduction Co. by virtue of mutual agreements with the other producers, and this fact, and the stoppage of the output at the French works, leave the market in Europe entirely dependent upon the Neuhausen Co. and the British Aluminium Co. The statistics which have just been issued by the Metal Co., of Frankfort-on-the-Maine, principally based upon estimates, show that the total production of aluminium in 1904 amounted to 8,750 tons as compared with 8,250 tons in 1903. The United States are credited with 3,400 tons of the former total, France with 1,700 tons, and the Swiss Co. with 3,000 tons, thus leaving apparently only 650 tons for the British company. As already mentioned, these figures are mainly founded upon estimates, and it is therefore interesting to turn to a calculation made by a technical correspondent of a Frankfort newspaper in regard to the approximate horse-power and production of the different manufacturers. The computation is given below:—

Company.	Situation of works.	Approx. water-power.	Approx. annual production in tons.
Aluminium Industry Co.	Neuhausen, Switzerland.	4,500	675
	Lend-Gastein, Austria.	15,000	2,250
	Rheinfelden, Baden.	5,000	750
British Aluminium Co.	Foyers.	5,000	750
	Sarpsfos, Norway.	10,000	1,500
Société Electrometallurgique Francaise.	La Praz, Savoy.	7,500	1,125
	Les Sordrettes, Savoy.	8,000	1,200
Société des Produits Chimiques d'Alois et de la Carmagne.	Calypso, Savoy.	10,000	1,500
	St. Felix, Savoy.	4,000	600
Pittsburg Reduction Co.	Niagara, New York.	11,000	1,650
	Shawinigan, Canada.	5,000	750
	Massena, New York.	12,000	1,800
Total	.. ..	97,000	14,550

It will be seen that the estimated annual production of aluminium in Europe, on the assumption that the tabular statement is correct, is represented by 10,350 tons, and as the French output alone is 4,425 tons, the stoppage of the works in France for a few months will materially tend to strengthen the market during that period. When, however, the effects of the labour troubles have been overcome, the quantity of aluminium produced will not only be brought to its former tonnage, but it will also be increased. This is explained, first, by the large extensions being carried out by the Neuhausen Co.; secondly, by the proposal of the Société des Produits Chimiques to increase by next spring the water-power utilised from 14,000 H.P. to 20,000 H.P.; and, in the third place, by the opening next month of a new works in central Italy, having an annual output of 600 tons.

TRAMWAY COMPANIES AND ROAD REPAIRS.

[FROM A LEGAL CONTRIBUTOR.]

A QUESTION of great importance to tramway companies sometimes comes before the Courts for consideration, namely, whether and how far the company is liable to do repairs to the roadway or street along which the track is laid. *Primâ facie*, of course, the burden duty of repairing a highway is upon the highway authority, *i.e.*, the local authority who carry out the work and defray the cost out of the rates; but it is obvious that when a tramway company obtain under an Act of Parliament a "limited monopoly" (if we may use the expression) of a certain part of the road, it is but reasonable that some part of the cost of maintaining that part of the road should be thrown upon them.

With the substitution of electricity for horses as a means of propulsion, the bearings of this question have somewhat altered during recent years. In the old days, when every tram belonging to a company was drawn by horses, it was necessary for the company to keep the portion of the track between the rails in good repair for the benefit of their own horses. With the advent of electric traction this necessity has disappeared. So long as the tramrails are kept firm and in good condition, it is a matter of indifference to the company whether the setts or macadam which fill up the rest of the road are in good condition or not. The Tramway Acts, however, place upon the company a heavy liability in this respect.

It is proposed in this article to consider the sections of the Tramways Acts which impose this liability, as illustrated by numerous cases which have been decided upon the construction of those sections.

Section 28 of the Tramways Act, 1870, makes it clear that the liability to maintain and repair the roadway is on the promoters. It is there provided that "promoters shall, at their own expense, and at all times, maintain and keep in good condition and repair, with such materials as the road authority shall direct, and to their satisfaction, so much of any road whereon any tramway belonging to them is laid, as lies between the rails of the tramway and (where two tramways are laid by the same promoters in any road at a distance of not more than 4 ft. from each other) the portion of the road between the tramways, and in every case, so much of the road as extends 18 in. beyond the rails of and on each side of any such tramway . . . . If the promoters fail to comply with the provisions of this section, the road authorities, if they think fit, may themselves, at any time after seven days' notice to the promoters, open and break up the road, and do the works necessary for the repair and maintenance or restoration of the road to the extent in this section above mentioned, and the expense incurred by the road authorities in so doing shall be repaid to them by the promoters."

It is clear that this section relieves the highway authority of a burden which it places upon the promoters. The question then arises—What is the meaning of the phrase "Maintain and keep in good condition and repair"? It obviously places upon the promoters the duty of repairing the pavement when it gets worn away; but decided cases seem to show that it includes much more than this. In this connection reference may be made to the case of Dublin United Tramways Co., Ltd., *v.* Fitzgerald ((1903) A.C. 99), which came before the House of Lords in 1903. It illustrates in a somewhat forcible manner the full extent of the burden which is imposed upon tramway companies. It appeared that, owing to the slippery state of one of the streets in Dublin, an accident took place whereby injury was done to a horse and cart. The owner of the cart brought an action against the Dublin United Tramways Co. for negligence. Sec. 37 of the Companies Act, which delimited their liability for maintaining the street, provided as follows:—"The company shall maintain and keep in condition and repair, and so as not to be a danger and annoyance to the ordinary traffic, the rails substructure, wires, posts, &c., and the paving." Sec. 28 of the Tramways Act, 1870, was incorporated with the Dublin Act. It was argued, on behalf the company, that their liability only extended to maintaining the fabric of the road; but this argument was rejected, and in the event the company were held liable. The case may now be cited as an authority for the important proposition that the duty of repairing a tramway track carries with it the duty of laying sand in order to prevent horses slipping in the streets. If, as we have already suggested, it is of no concern to the company that the setts or other surface of the roadway is out of repair, it is obviously no concern of theirs that the setts should be kept from being slippery. In the old days they would lay sand to prevent their own horses from slipping; under the new *régime*, they must lay sand for the benefit of other people's horses.

It has been held that the removal of snow, the presence of which rendered a road impassable, was part of the maintenance of a road within the meaning of the above section (Ogston *v.* Aberdeen District Tramways Co (1897) A.C. 111), and that the promoters must remove such snow; but the same case is also an authority for the proposition that in removing snow from their part of the road the promoters must not create a nuisance to any other part. In that case the defendant company had cleared their tracks by means of a snow plough which heaped up the snow on either side of the street, and had scattered salt on the rails. The House of Lords held that they had committed a legal nuisance.

It is not quite clear from the report of the Dublin case (*ubi supra*), how far the liability of the company depended upon the provisions of their own Act as distinct from the provisions of Sec. 28 of the Tramways Act, 1870. At the same time, it should be noted that Mr. Robertson, in his well-known work on the law of Tramways and Light Railways, cites the Dublin case as an authority for the proposition that a tramway company must lay sand upon their track.

For the purposes of general illustration, however, it is better to look at cases which have been decided inconnection with the general Tramways Act. These may be summarised as follows:—

The road authority has no power to order the promoters to alter, at their own expense, the material which has been once approved, so long as the promoters keep it in repair (Leek Improvement Commissioners *v.* Staffordshire J.J. (1888) 20 Q.B.D. 794) The promoters are bound to provide for the scavenging, cleaning, and watering of their part of the road, except in so far as is necessary for its maintenance and repair (R. *v.* Essex J.J., 1888, 4 T.L.R. 676). [NOTE.—This decision is somewhat difficult to reconcile with the Dublin case, where the promoters were held liable to lay sand, and with the Aberdeen case where they were directed to remove snow. As already stated, however, the House of Lords may have given particular weight to the special words of the Dublin Tramways Co.'s Act.] One other case decided upon the words of a particular statute is worthy of notice.

In the case of the Mayor, &c., of Norwich *v.* the Norwich Electric Tramway Co. (the *Engineer*, July 23rd, 1904), an action was brought by the Corporation of Norwich to recover certain expenses incurred by them in the repair of a road along which the defendant company had laid a line. It appeared that the road round the metals was paved with stones, while the space between the track and the kerb at either side was filled with macadam. Owing to the macadam falling into disrepair, there was a drop between the stone pavement and the macadam, which rendered the road dangerous to

passing traffic. The Corporation having levelled up the macadam so as to make a clean junction between the macadam and the pavement, brought this action to recover damages from the company. It is provided by Sec. 57 Sub-sec. 5, of the Norwich Electric Tramways Act, 1895, as follows:—"If the company fail to maintain and keep in good condition to the satisfaction of the Corporation . . . (5) the junction of the paving laid and maintained by the company with the surface laid and maintained by the Corporation, the Corporation may, if they think fit, themselves, at any time after seven days' notice to the company, do the work necessary for the repair and maintenance of the road, and the expense reasonably incurred by the Corporation in so doing, shall be repaid to them by the company, with the addition of 5 per cent. of such expense. Having regard to the stringent provisions of this section, Mr. Justice Phillimore was bound to give judgement for the plaintiffs; he said:—"The obligation of the company, under Sec. 57 (5) of the Norwich Electric Tramways Act, 1897, to maintain and keep in good condition the junction therein mentioned, extends to cases where, by reason of the presence of tramways in a road, the traffic in such road has caused the surface laid down and maintained by the Corporation to become worn down below the level of the paving laid and maintained by the company of a uniform and unbroken contour of such surface and paving, whether it is to be effected by the raising of the surface immediately adjoining such paving, or the lowering of the paving itself."

In the case of the Mayor of Middlesbrough *v.* the Imperial Tramways Co. (ELECTRICAL REVIEW, May 24th, 1901, p. 870), a question arose whether a tramway company could be held liable for alleged nuisance caused by washing out the tramlines with water. The plaintiff sought an injunction to restrain the defendants from pouring water on the lines of their tramway within the borough. It was alleged that the defendants had watered the lines to such an extent with the ordinary moving tank, that the highway had become rotten and unsound. The witnesses called by the defendants proved that this was the customary way of washing the lines, and that it was necessary for the purpose of preventing sparking and slipping. Mr. Justice Wright gave justice for the defendants, saying: "I am satisfied that the system of cleaning tramways is a proper one. . . . If there was a serious nuisance, it was only when the company were experimenting a few days after the trams were opened; since then any nuisance there has been, has been caused by the fact that the roads were flat and were not provided with proper gutters."

This case appears to show that a tramway company are not, at any rate, liable for any nuisance which may be shown to be attributable not to any action of theirs, but to some defect in the configuration of the road.

Having considered the liabilities to which the promoters of a tramway are exposed, it remains to discuss the question whether they can divest themselves of liability in any way. As we have already seen, Sec. 28 of the Tramways Act, 1870, provides that if the promoters fail to do the work, the road authority may do it for them and sue for the cost. Sec. 29 of the Tramways Act, 1870, provides that both the road authority and the promoters may enter into contracts to have the whole or any portion of the roadway in which trams are laid kept in repair. The case of Barnett *v.* Poplar Borough (17 T.L.R., 461) may be here referred to. There the plaintiff brought an action against the highway authority in Poplar to recover damages in respect of an injury caused to a van by coming in contact with a tram-rail which projected above the level of the street. The tramway company had entered into a contract with the highway authority handing over all liability in connection with the road repairs to them. The existence of such an agreement having been proved, the Lord Chief Justice and Mr. Justice Lawrance held that the defendants were liable.

Another case goes even further than this. By Sec. 55 of the Tramways Act, 1870, it is provided that the promoters or their lessees shall be answerable for all accidents, damages and injuries happening through their act or default. . . . or in consequence of any of their works . . . . &c. In Howell *v.* Nottingham Tramways Co. (12 Q.B.D. 16), it was held that an injury could not be considered as due to the promoters' act or default, where, owing to the contract, they were not responsible for the repairs which caused the injury.

It must not be assumed, however, that a tramway company can divest themselves of legal responsibility by employing a contractor to tear up and effect repairs to the roadway. In such cases the tramway company remain liable. Thus in Hardaker *v.* the Idle District Council, a District Council being about to lay down a sewer under their statutory authority employed a contractor to construct it for them. In consequence of his negligence in carrying out the work, a gas main was broken, and the gas escaped from it into the house where the plaintiffs resided, and an explosion took place, by which the wife was injured and the furniture was damaged. In an action by the plaintiffs against the District Council and the contractor, it was decided that the Council owed a duty to the public (including the plaintiffs) so to construct the sewer as not to injure the gas main; that they had been guilty of a breach of this duty; that, notwithstanding they had delegated the performance of that duty to the contractor, they were responsible to the plaintiffs for the breach; and that the damages were not too remote to be recovered. "If," said Lord Justice Lindley, "the contractor fails to do that which it is the duty of the Council to do or to get done, their duty is not performed, and they are liable accordingly."

The heavy liabilities which are imposed upon tramway companies in the manner above described should not be lost sight of by those who say that these concerns are worked for the benefit of their shareholders alone. What are the facts? At the commencement of their undertaking, the tramway company put the greater portion of the roadway in a state of thorough repair, often substituting well laid pavement for worn-out macadam. This they do at their own expense, to the great relief of the ratepayers. The cases referred to above show that the liability of the tramway company to repair is a continuing liability of no mean order.

THE DIFFUSION OF LIGHT.

IT frequently happens when a new or improved method of developing artificial light becomes of practical utility, and its exploitation falls partly into the hands of men whose knowledge of theory is not sufficiently extensive to render them afraid of making categorical statements, that assertions are put forward to the effect that the light in question exceeds all others in diffusiveness or power of diffusion. Soon afterwards disbelievers in the merits of the light seize the best opportunities they can to proclaim that it is deficient in diffusiveness, and this kind of warfare goes on indefinitely without either combatant condescending to offer proof, or even evidence, that real grounds for his belief exist.

In these circumstances, it may be well to consider whether light possesses such an intrinsic property as diffusiveness—that is to say, whether one kind of light diffuses or passes through air better or worse than another. First, however, it should be postulated that we are considering only such forms of light as have been found of practical value in everyday life, and that we are dealing primarily with the domestic or social applications of such light—*e.g.*, the illumination of a room, public building or street. The monochromatic light of the laboratory and the employment of a polychromatic light for projection over extreme distances, as in lighthouses, are different things altogether.

Once developed, all artificial lights (with the exception of the mercury vapour arc) are so much alike that they may be said to be qualitatively identical. If we possessed (it is doubtful whether we do) as absolutely precise an objective method of analysing a heterochromatic light as the chemist has for ascertaining the composition of a mixed substance, we should presumably find that all lights are quantitatively very similar. In all artificial lights we should find present rays of all, or very nearly all, the different wave lengths that exist in the sun; the only difference being that the ratios between the amounts of light of different wave length in each different polychromatic light are somewhat different. Hence it is that different lights strike the eye as being different in tint, and seem to affect the photographic plate to a different extent, even when, to our limited powers of observation, the total polychromatic illumination developed is the same. It must not be forgotten that an artificial light may appear to the eye tinted—say, red—for any of three or four causes: (1) it may be monochromatic, or essentially so—*i.e.*, composed almost entirely of red rays; (2) it may be heterochromatic, containing all its constituents except the red in nearly the same proportions as exist in a well-balanced white light, but with an excess of red; (3) it may be made up as the last, but with normal proportion of red, its apparent redness being derived from a deficiency in the green, which is complementary to the red; to perhaps, (4) the want of balance may be spread over rays of several wave lengths other than red, which together make a kind of complementary colour to the red, the comparative poverty of the light in those several rays allowing the red to be predominant. Of course, except in quantity or proportion of the total, the light which is composed of rays of a given wave length is absolutely identical, whether its source be the sun, a candle or a perfectly monochromatic light emitting that particular wave length.

Hence, however a polychromatic light is developed, the result is not only qualitatively identical, but it is largely, if not principally, identical quantitatively; for we may say that the minimum proportion of rays of any given wave length in any practicable light is not so very much smaller than the maximum proportion of the same rays in any other practicable light; and when it is shining for a distance measured only in yards through an atmosphere composed solely of gases and vapours, it is shining through an atmosphere which never differs seriously in the relative proportions of its gaseous constituents, but only in its temperature, and in the amount of vapour (water vapour) present. But, inasmuch as the various constituents of different lights are identical among themselves, each constituent must behave in the same fashion, however it be developed, as it passes through air; and therefore one polychromatic light, considered as an indivisible entity, cannot be affected by its passage through air in a fashion appreciably different from that of any other polychromatic light. On the other hand, it is perfectly conceivable that rays of one wave length travel through air more easily (so to say) than rays of another wave length; or that differences in the amount of moisture present affect the travelling power of monochromatic light more in one part of the spectrum than in another.

Assuming, however, selective absorption of this character to occur in an atmosphere of gases and vapours only, if we could split up with the chemist's objective accuracy any particular beam of light, the results of analysis would be different if the "sample" were taken close to the source from those obtained at a distance; and if the absorption were serious, the optical and photographic effects of the light at different distances would not be even approximately identical among themselves when corrected for the distance by the law of the squares. The most conspicuous result of such selective absorption would naturally be that a light should appear to the eye different in tint at a distance from what it does when observed close

at hand. In the conditions we have postulated, this is not the general experience. The human eye is not an exact measuring instrument as perhaps the photographic plate is in certain portions of the spectrum; but we are not aware that photographic results obtained in a pure gaseous atmosphere demonstrate any alteration in composition of a heterochromatic light during its journey. We use the word photographic in its conventional sense, meaning the effect on a film of silver bromide emulsified in gelatine, or the like.

When we come to consider the extraordinary conditions of a beam of heterochromatic light travelling miles over the sea, or yards through a mist or fog, we have a very different state of affairs. The air over the sea is not merely air more nearly saturated with true water vapour than the air in occupied buildings, but it is very frequently also charged with enormous numbers of minute particles of liquid water (spray); just as the air on land during a sea mist or clean country fog is still more heavily charged with liquid water, and is no longer transparent. During its extended journey the lighthouse beam of light encounters masses of air of different temperatures, and of different degrees of saturation, *i.e.* of different densities; and at the surfaces of contact a little reflection, and a little refraction, no doubt, occur. Thus, being originally polychromatic, the beam is split up into its constituents to a small extent, and its separate constituents are then left to travel alone, to be refracted further out of their first path according to their natural angle, to be totally reflected at some surface bounding two masses of air, or to combine again with other monochromatic rays to produce once more light of the first colour. The common presence of spheres of liquid water aids materially in the reflection and refraction of the light; and although the latter effect is presumably much too slight at any one spot to yield a light which the eye would recognise as coloured, in time even a parallel beam, which ideally remains of constant strength, is weakened in proportion to the distance travelled. During a fog at sea or in the country, when the light is only being transmitted yards instead of miles, a very similar effect is produced, the extra amount of liquid water compensating for the shorter distance travelled; and here it is often more or less correctly observed that an artificial light is yellowed somewhat, just as the sun is reddened at sunset by preferential absorption of the complementary ray or rays as its light passes through an unusual amount of moisture-laden air during the last stages of its journey to the earth. At least when liquid water is absent, the preferential absorption and degradation of certain rays (presumably those nearer the violet end of the visible spectrum) is too slight to cause a "green" artificial light to be mistaken for a "white" one, or a "white" light for a "red" one; but it is apparently large enough at long distances to enable a nominally white light, in which yellow and red rays are somewhat superabundant to travel further, and yet be recognised by the eye as a white light than is the case with a nominally white light in which the green, blue, or violet rays are in excess. In the mist the same thing happens to an enhanced degree. During a city fog, much dark coloured and more or less opaque solid matter exists in the air, most of it being probably present as a coating on the spheres of liquid water. This foreign matter should be opaque to light as a whole, and, broadly speaking, should produce equal effects on all forms of natural or artificial light, by merely blocking its path. The only noteworthy part that dirt of this kind can play in chromatic phenomena is to cause a very slight yellowing or browning of the light as a few of the rays are reflected with a yellow or brown tinge from the surfaces of the soiled water spheres, and as a few other rays pass through such layers of dirt as are composed of imperfectly opaque brownish matter of a tarry character.

(To be concluded.)

POWER PLANT ECONOMY.

A peculiarity of all routine work is its gradual progress towards simplification, but this very simplification increases the dullness of it all. Again, the more familiar one becomes with any particular duty, the more do the details of that duty obtrude themselves. No sooner are the details fully comprehended, than the desire to tabulate and classify asserts itself, and so we find that in that most highly specialised branch of engineering—the generation of electricity from fuel—the whole series of operations is now performed on more or less hard and fast lines. We do not, however, remember having previously noticed any attempts to bring the whole business down to a mere matter of $x = f(y)$, though Mr. A. M. Taylor's I.E.E. paper of a year ago was a long step in this direction. At least one engineer, notwithstanding, has contrived to give us "a temporary expedient until something more reliable can be compiled," by which we may determine the amount of electrical energy we may expect to get per pound of fuel burnt, under various conditions, with a given plant. As its author remarks, the attempt would seem an absurdity when we consider the number of varying conditions obtaining. On the strength of the close agreement between the results of his calculations and modern commercial attainments, we are presented with the former in the form of two tables in an article appearing in the October issue of *Power*. The figures have been compiled from data supplied to Messrs. C. C. Moore & Co., of San Francisco, concerning a number of stations on the Pacific Coast operating engines of the cross-compound condensing type, using saturated steam and direct coupled to electrical generators.

After mentioning the principal causes of loss of efficiency in the generating plant, the author—one of the engineering staff of Messrs. Moore & Co.—proceeds to explain how it is possible to calculate fairly closely the probable efficiency of any plant along the following lines:—

All machinery, owing to legitimate wear and repairs, experiences a general decline in economy. This he assumes as 10 per cent., taking for comparison a waterworks pumping station as having a steady full load, while still including all the losses incidental to the normal running of a steam plant. Then taking a typical efficiency curve for a direct coupled unit in conjunction with the known steam consumption of the type of engine in question, he arrives at a relation giving relative steam economy at different fractional loads as measured at the switchboard. From this, the next step is to include the boiler plant and auxiliaries, whence, calculating from the known efficiency curve of the boiler and assuming a slightly increasing rate of economy of the auxiliaries, he gets a working result as follows:—

Percentage of full load output measured at the switchboard.	Relative fuel consumption per kw.-hour in per cent. of fuel economy at full load.
100 per cent.	100 per cent.
75 ,,	94 ,,
50 ,,	82 ,,
25 ,,	54 ,,

It is necessary to mention the few assumptions and qualifications made. The unit referred to has a combined efficiency of 87·5 per cent. at full load, so that larger units will give a relatively greater economy up to as much as 90 to 92 per cent. in the largest sizes; superheated steam and fuel economisers will also increase the economy. The total heat loss from steam piping, the whole of which is assumed to be under steam, is taken as the same at all loads and equal to 2 per cent. of the fuel consumption per hour during the peak; the loss of fuel due to banking fires is given as 3½ per cent. of the full load fuel consumption of the plant per hour. All boilers in use on the peak are kept under banked fires or in service for the full time, and the engines are cut in as soon as the load reaches the rated capacity of the plant in service.

From the data obtained as described, with the aid of an average load curve, the author draws up his first table, from which one may learn the economy to be expected from a plant of one, two, three or four units, under load factors of 100, 50, or 33⅓ per cent. when run for 24, 20, or 10 hours per day, under the conditions set forth above, with the rather obvious reservation that exceptional forms of load curve would necessitate considerable alteration in the figures. The units under consideration are from 250 to 500 kw. in size, and are run through a peak load equal to their rated capacity.

The writer of the article next proceeds to give a more pretentious table, giving the actual cost of power delivered at the switchboard, including fixed charges—also given in detail—and fuel charges for plants from 50 to 20,000 kw. in size, under similar conditions, except that the units smaller than 150 kw. are cited as "high-speed tandem compound non-condensing engines," and those in the 20,000-kw. plant as "Manhattan four-cylinder type, condensing."

The tables are most interesting, as affording a means of comparison between typical British and American practice—except that the stations referred to are using oil fuel—and as showing how much can be done in the way of analysis and calculation, but we question their practical utility. They are too general; and, moreover, we are of opinion that the same information embodied in a curve sheet, for which our esteemed contemporary is already famous, would have been more easily assimilated. One cannot but appreciate the large amount of work their compilation has involved, but the average station engineer is not concerned to be able to reckon with certainty the fuel consumption for any particular day, and we doubt whether the above method of arriving at the coal bill would, in any case, give a reliable check on the working of the plant, for reasons we have given. It is sufficient to know that each unit of plant is working up to its normal efficiency, and to be able to trace any deterioration as soon as it shows itself, with a view to the maintenance of the plant in the best possible condition. We venture to suggest, then, that ingenuity and labour expended along these lines would be vastly more profitable than the mere calculating and verification of a table of figures of probable operating efficiencies.

THE OVERLOAD AND REVERSE CURRENT RELAY.

[COMMUNICATED.]

The design of switchgear has during the last few years reached such a state of perfection, that, from being the weakest link in an electric installation, it can now claim to be as reliable and safe as the rest of the apparatus of the system. That it took many years to bring about this change, was mainly due to the fact that the vital importance of switchgear was overlooked, as also that wrong principles were used in the design.

The continuous current board has, since the introduction of the automatic circuit-breaker, faithfully performed its function both in lighting and traction work. Most of the continuous current circuit-breakers that one meets with in practice embody the same general features. The main contacts are generally relieved from the strain of the breaking current by supplementary contacts placed in parallel with the former. This supplementary circuit further contains a pair of strong

electro-magnets for blowing out the breaking arc. In the event of rupture, the main contacts disengage first, leaving the auxiliary ones to carry the breaking current. These latter are placed in a strong magnet field set up by the aforementioned magnets, and any arc formed at the moment the supplementary contacts disengage in their turn is speedily extinguished. Such circuit-breakers answer their purpose very well, although the sparking at the main contacts is not totally done away with, as by having blow-out magnets in the auxiliary circuit a certain amount of induction has been introduced, which gives rise to a small spark at the main contacts. This sparking is, however, too trivial to be taken into account. The newest tendency in continuous current circuit-breaker design seems to be to disregard the blow-out magnets altogether, and to rely upon carbon contacts for taking the breaking arc. The carbons will, of course, be arranged in such a way that frequent renewal is possible. By means of these carbon tips the sparking difficulty at the main contacts appears to be totally overcome.

Alternating current plants have been installed in great numbers, and have assumed great proportions since the commercial value of multiphase currents became recognised. In these plants, high potentials and not current strengths, enter as principal factor into the design of switchgear and apparatus. The phenomena attending high-tension currents, as also other characteristics of the alternating current circuit, such as capacity and self-induction effects, render it a most difficult problem to provide efficient and adequate controlling and protecting devices. The most essential point in high-tension working is to provide ample clearance everywhere, and to arrange the various apparatus in a symmetrical manner. The importance of these simple rules was for a considerable time overlooked, especially by station engineers themselves, who compelled, or at least encouraged, switchboard manufacturers in the crowding of their gear. Time has taught us now on which lines a board ought to be designed, and all modern high-tension switchgear installations present the following features :—

1. The switchgear is located in a specially designed building or bay of a building. The high-tension gear is installed in fireproof cells. The operating board is erected on a gallery, from where the whole of the machinery can be supervised.

2. Complete separation between high and low tension apparatus. Distant control adopted for the former either by electrical or mechanical means. All instruments are fed through step-down transformers; in this way only low-tension apparatus and connections appear on the operating board, thereby practically eliminating all danger to the manipulator.

3. Means are provided for isolating any part of the system, sub-stations as well as each separate unit.

4. Every part of the system is adequately protected. Absence of fuses in all main and feeder circuits, but instead *automatic time limit elements*, overload or reverse current as the occasion demands.

It is especially the last point which has for some years engrossed the minds of switchboard designers, and in view of its actual importance, a description of an instrument that meets all the requirements of present-day practice and is also being largely used in England, ought not to be unwelcome.

The purpose of this article is not to draw up a comparison between the automatic device and the fuse, as this matter was, in the writer's opinion, thoroughly thrashed out by Mr. Eborall in a series of articles which appeared in *Engineering*, in the autumn of 1903. Mr. Eborall demonstrates in the above articles that, apart from other advantages, the fuse "does not fulfil the requirements of an overload protecting device, as it has no selective action," in other words, so the author goes on, "it cannot be made to discriminate between forward and reverse currents, or to operate after a certain perfectly definite time has elapsed." This is, indeed, the main drawback to the fuse, and a sufficient reason for giving the preference to the electro-mechanical device, even if in all other respects fuses were superior.

It was only natural that the fuse should in the early days suggest itself as a protecting device, its low first cost being its chief inducement. At first when there was only a question of small current strengths distributed over a restricted area at low working tensions, the fuse answered the purpose very well, but with the growth of engineering, the outputs of machines increased to undreamed-of proportions, and the want of something more definite and responsive, something less sluggish in its action, but at the same time less disturbing in its effect, was felt, and the automatic electro-mechanical circuit-breaker was put on the market. Most of these automatic devices consist of a solenoid which sucks up a plunger when the current in the circuit rises above a predetermined density. These apparatus can be set for several current strengths by altering the position and, therefore, the stroke of the plunger. When the required tripping current is reached, the plunger knocks up forcibly against a trigger or catch, and the releasing mechanism opens the switch. This arrangement can be rendered selective by providing an electrically-operated dashpot, or in quite a number of other ways.

The automatic device which forms the subject of this article, was put on the market by Messrs. Brown, Boveri and Co., of Baden, Switzerland, and is protected by patent rights in most civilised countries. It has now stood the test of time for more than three years, and as it is a total departure from the above mentioned plunger-type circuit breakers, it is of special interest.

The Overload Relay.—The general idea of this instrument is as follows :—A little single-phase motor is fed from the main circuit through step-down transformers. This motor is kept stationary by means of a suspended weight. As soon as the current in the main circuit increases beyond a certain value, the torque of the motor overcomes the resistance of the suspended weight, and the latter is raised until at the end of its travel it establishes contact between two flat springs, and completes a direct-current auxiliary circuit which energises the tripping coil. The latter operates in the usual way. With the above brief description in mind, it will be easy to follow the more detailed explanation.

The principle underlying the working of the relay is based on the "superposition of two simple alternating fields differing in phase." This is by no means a new idea, but was advanced by Prof. Galileo Ferraris more than 11 years ago, when he demonstrated that "two superposed alternating fields, differing in phase with one another, produce a resultant rotating field or *vice versâ*." This theory is applied in this case in the following ingenious manner. The stator of the little motor consists of an alternate-current magnet energised directly from the system through a step-down transformer. An aluminium disk (the rotor) is made to revolve in the air-gap of this magnet (fig. 1). A copper ring is

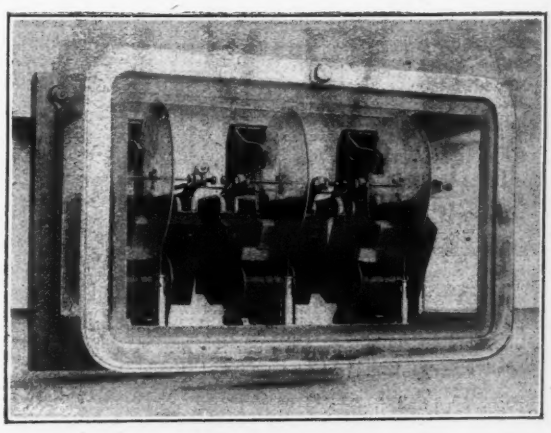


Fig. 1.—Overload Relay.

fixed to embrace half the face of the magnet. By means of this ring a field is created, differing in phase with the main flux. The two fields combine to give a resultant rotating field which sets up eddy currents in the aluminium disk. A driving torque is consequently produced in the latter, and the disk tends to turn. The spindle of the disk is horizontally pivoted, and carries a little grooved drum. On the circumference of this drum a silk thread is attached, which carries a weight. The weight holds the disk in check

as long as the torque, and consequently the current (the first only and wholly depending upon the latter) keeps within normal limits. As soon as the current in the system exceeds the safe limit, the disk starts rotating and winds up the thread on the little drum, until, at the end of its travel, the weight forces the two contacts together and completes the continuous current circuit. The tripping coil which is mounted on top of the oil switch casing (fig. 2) is fed from

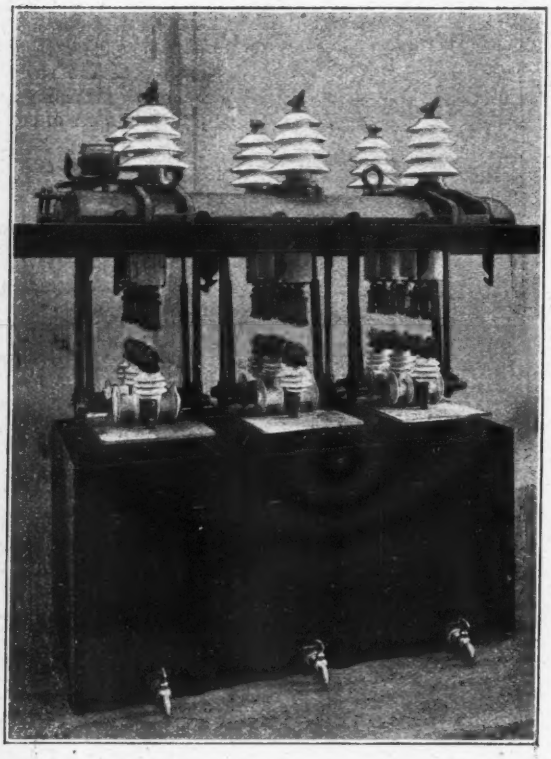


Fig. 2.—Oil Switch Fitted with Tripping Coil.

this circuit in such a way that as soon as the armature has been attracted by the solenoid and the switch opened, the supply of current to the said solenoid is cut off. This is accomplished by means of a small collector fixed on the switch spindle, whence the current is collected by means of brushes and conducted to the solenoid. As soon as the switch moves through a small angle, the brushes leave the collector and the current supply of the electro-magnet is interrupted in the above-mentioned manner. In order to retard, as well as steady, the motion of the aluminium disk, a strong brake magnet has been provided.

It will at once be seen that the above relay provides for :—(1) Ample margin for time adjustment (by altering the length of the silk cord); and (2) close adjustment for overloads (by increasing or decreasing the suspended weight).

The curve, fig. 3, shows the length of duration of the breaking process in seconds against the percentage of overloads. A glance suffices to demonstrate that the duration of the operation varies inversely as the overload, so that the apparatus can indeed claim to possess an "inverse time element" in the fullest sense of the word. The values of time are by no means fixed quantities, but can be altered to suit special conditions, simply by altering the length of the thread. The instrument from which the curve was taken was set to commence operating with an overload of 40 per cent., the time taken for winding up the weight being in this case 40 seconds; with an overload of 200 per cent., the relay responded in 2 seconds.

Messrs. Brown, Boveri & Co. have adopted a working current of 1 ampere throughout for all their relays. By standardising in this way, it is little trouble to adapt the relay to any circuit, the only variable being the ratio of transformation of the current transformer. The relay may be, and is commonly, fed from the same current transformer as the ampere-meter. This latter instrument must, for obvious reasons, be calibrated in such a way that the maximum deflection on the scale corresponds to a current of 1 ampere in the secondary of the instrument transformer.

The relays lend themselves equally well for single, two or three-phase systems, and are designed as single, double or three-pole types to suit the above circuits. A two-pole relay may be used on a three-phase system when the neutral point is not earthed. When, however, this point is grounded, then it is imperative to install a three-pole instrument, as, in the event of a fault developing in the unprotected phase, the circuit would be completed through earth, and the relay would not operate, and therefore would no longer act as a protecting device. The diagram of connections below (fig. 4) repre-

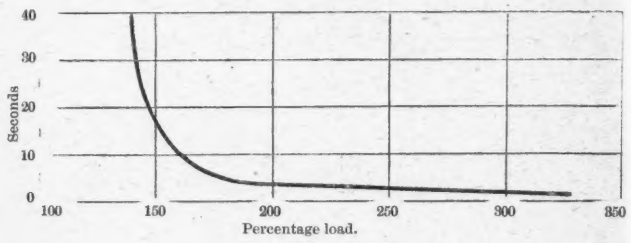
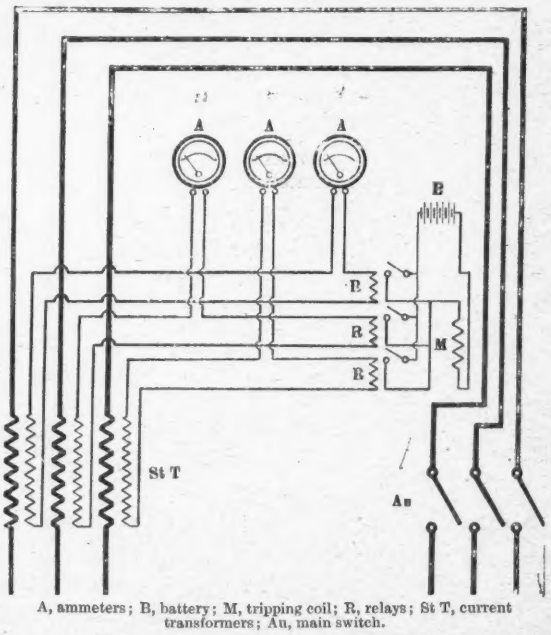


Fig. 3.

sents the relay adapted to a three-phase circuit. The wiring, it will be seen, is extremely simple. The stator coils of the relay are placed in series with their respective ammeters in the secondaries of the transformers. The tripping coil is energised from a small storage battery; this battery should be capable of supplying a current of from 1 to 1½ amperes at a pressure of from 15 to 20 volts. The tripping coil may be, and is in most central stations, directly fed from the exciter bus-bars. To bring the voltage down to the required value, a resistance



A, ammeters; B, battery; M, tripping coil; R, relays; St T, current transformers; Au, main switch.

Fig. 4.—Diagram of Connections for a Three-Phase Circuit.

is inserted in the tripping circuit. This resistance generally takes the form of lamps placed in parallel or series to suit the conditions. In sub-stations where absolutely no continuous current is available, the above mentioned accumulator battery is resorted to, the latter being periodically charged from a continuous current supply.

In power transmission plants where the current generated by the machines is directly led to the primaries of step-up transformers, one relay suffices for protecting both generator and transformer, by connecting the tripping coils in series with one another. The same holds good for transformer

sub-stations, only one relay being installed for protecting both primary and secondary winding of the apparatus.

(*To be concluded.*)

BUSINESS NOTES.

Cable Makers' Association.—The following circular has been issued by this Association:—

"As some considerable amount of misapprehension seems to have been created in the minds of electric cable users as to the objects and aims of the Cable Makers' Association as now constituted, we desire to state exactly what the present position of the association is. Some seven years ago the leading cable makers decided that, unless steps were taken to remedy the matter, the quality of the V.I.R. cables sold must ultimately deteriorate owing in great part to keen competition; and to prevent this they agreed amongst themselves to adopt as a minimum the competitive prices then prevailing, and to compete only in quality. To facilitate trade, and to protect the user, the cables of the three grades then most in use were standardised both as regards the weights and resistances of the copper conductors, the thicknesses of dielectric, and the protecting coverings overall. It was further decided that for these grades only the best rubber should be used, the quantity to be varied according to the grade, and the necessary ingredients added according to the experience of each manufacturer. Until recently only these association grades were made by the members of the association. Lately, however, a lower class of cable has been adopted by some users, and they have pointed out to members of the Cable Makers' Association that there is a real and legitimate demand for such cables for certain purposes, and that engineers and contractors would be glad to purchase in certain cases this lower class of cable from houses of good experience and repute who had hitherto abstained from selling any goods other than those of the high standard they had set up. As an outcome of these representations some of the members of the Cable Makers' Association placed on the market a lower class under the name of non-association cables, in the belief that, although admittedly the quality was lower, they should secure these special orders owing to their long experience in manufacture and their technical skill. This action and the recognition by engineers and contractors of the advantages of buying from makers of the highest standing has led those makers whose trade existed on the basis of low price alone to misrepresent the motives of the Cable Makers' Association. Having thus officially explained our position, we suggest that where cables of the best grade are required, engineers should specify association grades made by a member of the Cable Makers' Association, but in cases where an inferior class can be used, we believe the buyer will get the best value for his money by ordering non-association class from a member of this association. In order to prevent misunderstanding, the two classes have distinctive labels attached to the coils. Association cables have, under the canvas wrapping a yellow label, stating the class of cable and also its electrical particulars. This label is tied round each coil by a tape secured by a lead seal. The tape and seal must be broken before the coil can be unwound. Non-association cables have a green label giving similar particulars, which is attached to each coil in the same way. Outside the canvas wrapping each coil has an ordinary tag label—either yellow or green as the case may be—giving manufacturer's name and address and class of cable.

"The Anchor Cable Co., Ltd.
"The British Insulated & Helsby Cables, Ltd.
"Callender's Cable & Construction Co., Ltd.
"Connolly Bros., Ltd.
"W. T. Glover & Co., Ltd.
"W. T. Henley's Telegraph Works Co., Ltd.
"The India-Rubber, Gutta-Percha & Telegraph Works Co., Ltd.
"The London Electric Wire Co., Ltd.
"Siemens Bros. & Co., Ltd.
"The Western Electric Co."

Switzerland.—The Société Générale du Carbure de Calcium in Gürtnellen (Switzerland) have decided to build a new factory for the manufacture of metallurgical products, and notably of steel, according to the Kjellin system for which this company has exclusive right in Switzerland. The new works will shortly be ready. The manufacture of carbide of calcium will not be given up but will be carried out on a smaller scale.

An Electrical Contractors' Association at Cape Town.—A meeting of electrical contractors was held at Cape Town on the 24th ult. for the purpose of forming an Association on similar lines to the Electrical Contractors' Associations in England. The principal objects of the proposed Association referred to at the meeting were the prevention of unfair electric light regulations being adopted by municipalities and unjust clauses being inserted in specifications by consulting engineers, also the securing of trade discount to contractors on electric light fittings imported by consulting engineers. A provisional committee was formed for the purpose of framing rules, &c.

Private Installations.—The mansion, "Old Alresford House," Hampshire, is to be fitted up with a complete electrical installation, including oil engine plant and pumping apparatus. The entire work has been entrusted to Messrs. Duncan Watson and Co., of Charing Cross Road, W., who have also in hand important installations for the Central Foundation Schools, Finsbury, Murphy Memorial Hall, S.E., the Whitgift Grammar Schools in Croydon, and the new buildings which have been erected by the Whitgift Governors in North End; also a complete electric lighting suction gas plant for Leamington Steam Laundry, Warwick, and a number of motors and motor-generators for printing machines, cigarette making, and various other purposes, the motor-generators being used for experimental purposes in connection with an important college and technical school. This firm are said to be engaged in carrying out some of the largest arc lighting installations in London.

Curtis Turbine Contracts.—We understand that the British Thomson-Houston Co's sales to date of Curtis turbo-generators amount to a total of 24,000 kw., of which 11,750 kw. have been delivered and put in service in various stations in the United Kingdom. The principal orders show a total of 10 1,500-kw. sets, four 1,000-kw. sets, and four 750-kw. sets. The Curtis turbine rights in America are owned by the General Electric Co., of Schenectady, N.Y., who have received orders to date for 472 machines, aggregating 454,886 kw, of which 282 machines, aggregating 237,775 kw., have been delivered and are in use or in course of erection. Four sets of 8,000 kw. are under construction, and it is interesting to note that these will be the largest steam turbo-generators in the world. The list of orders also includes 30 5,000-kw. sets, 11 3,000-kw. sets, 31 2,000-kw. sets, 31 1,500-kw. sets, of which 15 5,000-kw. sets, 7 3,000-kw. sets, 16 2,000-kw. sets and 23 1,500-kw. sets have been delivered. This is an imposing list of orders, considering that the Curtis turbine has only been on the market for about three years.

Steam Railway Activity.—There is reported to be great activity at the L. & N.W. Railway works at Crewe, and the Christmas holidays were reduced in order to keep pace with the demand for rolling stock, &c. The *Times* says that a large number of new engines are being built, and, from the beginning of the new year, over 5,000 of the employés, in addition to the 3,000 put on fuller time recently, will be required to work on Saturdays.

Large Gas Engine Installation.—It is reported that the Francisco Light and Power Distribution Co. is about to install in San Francisco a gas engine of 4,000 b.h.p. Eventually there will be four engines of this size, three direct coupled to alternators working at 25 cycles per second, and one to a 60-cycle alternator.

Catalogues and Lists. — British Insulated and Helsby Cables, Ltd., Prescot.—Finely illustrated 32-page catalogue on the subject of the annealing of non-ferrous metals, giving a full description of the Bates and Peard patent annealing furnace.

The Electromotor and Dynamo Co., 15, Gray's Inn Road, Holborn, W.C.—A number of leaflets bound up together in an expanding cover allowing for additions. They describe and very fully show by means of half-tone blocks various electrical hoisting, lifting and controlling gear, including direct-driven electric friction hoist gear, spur-geared winches, tramway type reversing controllers, lift controllers, lift-gate locks, sundry lift gears, electric pulley blocks, travelling hoists, wharf cranes, goods lifts, and so on.

Messrs. Baxendale & Co., Miller Street, Manchester.—20 pages illustrated catalogue of luminous electric radiators, also loose leaflets of the "clincher" plug, and portable instruments for lamp testing.

The Electrical Co., Ltd., London.—Brochure (26 pages) devoted to the many applications to which electricity has been, and may be put in shipbuilding and similar yards. The views well illustrate an electrically-driven saw-mill with various types of sawing machines, also punching and shearing machine, scarfing machine and straightening rolls, drilling machines, lathes, pug and sand mills, pneumatic hammers, pipe-cutting saw, rattler, blowing fan, &c. It is stated that most of the electrical equipments illustrated in the book were adopted for the conversion of Messrs. Harland & Wolff's shipbuilding yards from steam to electric driving. Other leaflets received from the Electrical Co., Ltd., are as follows:—No. 191 devoted to Rignon small arc lamps; No. 194, dealing with small motors; and No. 151/1 giving comparisons of Nernst with ordinary glow-lamp lighting.

The British Thomson-Houston Co., Ltd., Rugby.—Illustrated pamphlet No. 190, giving a full account of the Mercury arc rectifier, of which we published a description in our issue of November 24th, 1905, p. 864.

Messrs. Mechan & Sons, Ltd., Glasgow.—In several well got up pamphlets, the Watkinson patent steam superheaters of independently-fired, shunt circuit, flue-fired and marine uptake types are particularised, also the Watkinson steam dryers for extracting water and grit from high pressure steam, and oil separators for the removal of oil and grease from exhaust steam. A comparative summary of results of trials of saturated and superheated steam, and diagrams illustrating the effect of superheat on steam consumption, are included among the other features.

The Titan Packing Co., 2 and 3, Tower Royal, Cannon Street, E.C.—New catalogue giving illustrations, particulars and prices of "Titan" rubber and asbestos goods, including black and red "Solvis" jointing, spiral piston packing, gaskets, asbestos packings and jointings, adhesive tape, metallic packing, corrugated metallic rings, &c.

London Electric Fittings Co., Ltd., Hampstead.—A 16-page pamphlet showing various designs of L.E.F. electric radiators and giving prices of same. A picture-postcard from the company gives a good view of a cosy corner in their Soho Square showroom with a fine variety of artistic electric fittings.

C. W. Hunt Co., U.S.A.—Fully illustrated catalogue of the "Hunt" automatic railway as employed at the Dublin United Tramways power station and many other places in different parts of the world.

General Electric Co., Ltd.—Section "H" of their catalogue giving particulars of heating and cooking apparatus, radiators, &c. To enumerate all the particulars here illustrated and described is not necessary, but in addition to the numerous variety of electric kettles, saucepans, ovens, and so on, there are such things as auto-service water heaters, hot water jugs, and sealing wax heaters, which are specially noteworthy.

Messrs. O. C. Hawkes, Ltd., 69-70, Aldersgate Street, E.C.—New issue of their catalogue No. 19 relating to patent induced draught electric stoves and fittings of artistic and original design. The firm have a very lengthy record—some 36 years—as art metal craftsmen, and the experience and reputation so obtained have been brought by them into the heating department of the electrical industry. A variety of very fine examples of drawing room designs of electric stoves, also electric light fittings in combinations of metal, wood, glass and silk are illustrated. At the firm's show-rooms, at 69 and 70, Aldersgate Street, E.C., a selection of these special lines is placed on view.

Messrs. Alley & MacLellan, Ltd., Glasgow.—Catalogue (104 pp.) in which are given very fully detailed particulars with many explanatory line diagrams, excellent half-tone illustrations and curves of the "Sentinel" air compressors. Vertical compressors for belt and steam driving, horizontal for belt, steam and motor driving, also vacuum pumps and sundry valves re-heaters, traps and so forth are described. Views of the works' extensions, lists of users and some hints on piping, and general tabular information are included.

Westinghouse Brake Co., Ltd., King's Cross, N.—A new catalogue describing the various types of Westinghouse brakes for light railway and tramway systems. These are compressed air storage and motor compressor types; air brake apparatus. Numerous diagrams, also half-tone illustrations of the several parts appear.

Messrs. Hayward-Tyler & Co., Ltd., Queen Victoria Street, E.C.—List M (36 pp.) containing particulars and many excellent small half-tone views of the firm's electrically-driven and other treble-barrel pumps.

Messrs. Ferranti, Ltd., Hollinwood.—Catalogue No. 54 devoted to double-pole, double-throw, quick-break knife switches.

Messrs. Mather & Platt., Ltd., Manchester.—New catalogue fully describing and illustrating the firm's Rosenberg patent system of electric train lighting. A specification with detailed diagrams are included.

Messrs. David Wilson & Co., Huddersfield.—Illustrated list of lightning conductor, chimney repair and other work executed by the firm.

Dissolutions and Liquidations.—The Electrical Ore-Finding Co., Ltd.—Winding up voluntarily, with Mr. J. D. A. Norris, Suffolk House, Laurence Pountney Hill, E.C., as liquidator.

Barcelona Tramways Co.—Creditors must send particulars of their debts, &c., to Mr. J. B. Glenn, Salisbury House, London Wall, E.C., by January 31st.

Graham, Morton & Co., Ltd.—Voluntary liquidation decided upon. Circular offering £10,000 new capital met with disappointing response, and advisory committee convened meeting for 21st inst. at which this decision was arrived at.

Bankruptcy Proceedings.—Wm. Leslie, electrical engineer, Putney.—First meeting to be held January 2nd, at 132, York Road, Westminster Bridge; public examination, January 25th, at Wandsworth Court House.

The Austrian Cable Industry.—Count Auersperg, of the Austrian Ministry of Commerce, recently granted an interview to Herr R. von Heller, who took the opportunity of submitting a report in regard to the Austrian cable industry. He pointed out that some of the Austrian works had been induced by Hungary to undertake the manufacture of cables also in the latter part of the monarchy. As a matter of fact, the leading cable companies have erected branches in Hungary which have largely developed, and the Hungarian cable industry is now almost equal to that in Austria. Those Austrian cable-makers who have not started branches in Hungary have recently been entirely eliminated from deliveries both for public and private demand in Hungary, and as the old condition of affairs still prevails in Austria in respect of the method of distributing orders for public contracts, the Austrian works having no Hungarian branches suffer from the operation of this method of open and free competition. As a result of this report Count Auersperg has promised to investigate the question thoroughly, and it is said that he will also advise contractors invited to tender for public works to give first consideration where prices are similar to those Austrian firms whose factories are solely situated in Austria. The matter is regarded as of great importance, as extensive public works are in prospect.

Since the foregoing was written the Austrian Felten and Guilleaume Co., the Cable Works Co., and the Siemens & Halske Co. have issued a statement disclaiming any connection with the representations made to the Minister of Commerce. As the most prominent representatives of the Austrian cable industry, they observe that Herr R. von Heller is entirely unknown to them, and that he was not authorised to convey wishes or complaints on their behalf to the Minister. The representations made, they further state, were not in accordance with the general interests of the Austrian cable makers, but only indicated the special standpoint of one firm.

Calendars and Diaries.—Once again the Electrical Power Storage Co., Ltd., has favoured us with one of its very serviceable desk blotting pads with diary and memoranda book, and with monthly card slips conveniently placed at the top. Each pad has as usual the acceptable £500 Railway Accident Insurance coupon. Illustrated and tabulated particulars of the E.P.S. batteries and specialities are, of course, given, and some loose lists detail miners' electric safety lamps, laboratory batteries, &c.

A wall calendar with monthly tear-off sheets has been received from the *Chemical Trade Journal*.

A neat pocket diary for 1906 with insurance coupon, and some information relating to their well-known specialities, is being circulated by the Simplex Steel Conduit Co., Ltd. The book is arranged to serve both as a diary for engagements and for keeping an alphabetical list of addresses.

We are again indebted to the British Electric Transformer Co., Ltd., of Hayes, for our copy of Whitaker's Almanack for next year. In the experience of most of us occasion arises to consult our indispensable Whitaker many times in the course of the year. The Hayes Co. takes advantage of this excellent opportunity for keeping its name before its friends, and is circulating this "Morocco Bound" volume into which it has introduced illustrated and other matter relating to its manufactures.

From Mr. John Whitelaw, engineer, 15a, Duncan Street, Edinburgh, we have received a bright desk calendar with monthly cards.

Trade Announcements.—The Private Wire and Telephone Installation Co., Ltd., have just removed to premises acquired by them at 78, Queen Street, Cheapside, E.C., where they have extensive showrooms equipped with every kind of electric fittings. They have facilities there for charging and repairing accumulators, and thus will meet a want amongst many motoring men who daily come to the City. This company commenced its operations close on 12 years ago, and, owing to the increase in its business, it has been compelled to remove from Palmer Street, Westminster, where its offices have been for so long.

Messrs. Bruce Peebles & Co., Ltd., announce that their works will be closed for the annual audit and stocktaking from December 30th until January 8th.

Mr. F. E. Mackee, who has been with the British Insulated and Helsby Cables, Ltd., for nearly 11 years, has now left this company and started business with Mr. O. M. Robinson, of 13, Castle Street Liverpool. In future, all inquiries should be addressed to Frederick E. Mackee & Co., electrical engineers, 22, Crane's Buildings, Liverpool.

Book Notices—"Luton as an Industrial Centre."—The municipal authority at Luton is endeavouring to attract the attention of those connected with industrial concerns to the many advantages obtaining in the Corporation area for the erection of factories and works. The Luton Chamber of Commerce and the Corporation New Industries Committee have shown no little enterprise in issuing this nicely got-up booklet, which contains many illustrations. We record to-day in another column the fact that the electrical charges at Luton have been further reduced, power gas charges are low, the water supply is good and the rates very moderate. Those interested in a site for new works should obtain a copy of this interesting booklet.

Harmsworth Self-Educator. In 48 fortnightly parts. Edited by Arthur Mee. London: The Amalgamated Press. 1905. Price 7d. per part.—The current age is remarkable for two special features: the monumental work in a lump, paid for over a series of years; and the monumental work in parts, paid for as they come. The Harmsworth Encyclopædia has run about half its course, and already it is being followed, or accompanied, by the Harmsworth Self-Educator—both bi-weekly, and both entailing the expenditure of precisely a halfpenny per day, neglecting interest. The idea of the new serial seems excellent, and its execution is no less praiseworthy. The articles are mostly by experts, and are written in a style and illustrated in a manner which, so far as we have seen, are most admirably adapted to the purpose in view. Many of the illustrations, indeed, compel our admiration. The syllabus of subjects dealt with, comprising 29 groups, covers practically all the more important interests of mankind, each being sub-divided into a number of subsidiary headings. No fewer than 28 subjects are dealt with in serial form simultaneously, including in the earlier parts those subjects of most pressing interest. The section on Electricity is in the hands of Dr. Silvanus Thompson, than whom it would be impossible to find an author more competent to deal with the subject in the most appropriate way. Doubtless many of our readers will subscribe to this valuable publication—we can assure them that, old or young, rich or poor, they will find in it much to interest, instruct, and perhaps to amuse them.

"*Mathieson's Handbook for Investors for* 1906." London: F. C. Mathieson & Sons, 16, Copthall Avenue, E.C. 2s. 6d. net. This is an essential work for those who need at hand a conveniently arranged record (pocket size) of Stock Exchange prices and dividends of fluctuating securities for the past ten years. A 1s. supplement to the Mining Handbook gives the highest and lowest mining prices, dividends, &c., for the past six years.

"Uber das Nachleuchten der Luft bei Blitzschlägen." By B. Walter. Reprint from *Annalen der Physik*. Leipzig: J. A. Borth. 1905.

LIGHTING AND POWER NOTES.

Bacup.—The Corporation has agreed to take a supply of energy in bulk from the Lancashire Electric Power Co., for private lighting and power purposes, commencing with the new year. The question of street lighting is not yet settled.

Barnstaple.—A L.G.B. inquiry was held recently into the T.C.'s application for power to borrow £4,000 for E.L. extensions. It was stated that a large proportion of the sum had already been expended in the laying of cables and on extensions. The Council has reduced the charge for lighting from 6d. to 5d. per unit. A ratepayer, interested in the local gas company, opposed the application, contending that, in order to make the undertaking pay, the charge for public lighting had been increased from £691 to £2,043.

Barton.—The R.D.C. has declined to accede to the request of the Flixton P.C. to exclude the parish from the E.L. order being applied for by the former Council.

Bootle.—On the 21st inst. a short circuit occurred on one of the generators, and the supply for lighting was curtailed for about half an hour.

Burnley.—The T.C. has adopted the borough electrical engineer's proposal to divide the lighting network by means of disconnecting fuse pillars into five areas, at an estimated cost of £450. The above will meet the requirements of the B. of T. regulations, and reduce the possibility of failure in the supply due to a fault on the mains to a minimum.

Burslem.—The L.G.B. has sanctioned the borrowing of £5,500 for the purposes of extending the E.L. mains to Tunstall.

Canada.—Montreal.—According to a local paper the Chambly power station of the Montreal Light, Heat and Power Co. was recently shut down owing to minute particles of frost getting into the machinery and stopping the turbines. The shutting down of this station caused much dislocation of the tramway service and the failure of the E.L. supply. Eventually the steam plant at the company's William Street station was got into operation and a full supply of energy was available. The Chambly power station, we gather, has a capacity of 20,000 H.P., and this is the second time this season, the plant has failed.

Chobham.—The P.C. on December 13th decided to ask the R.D.C. to oppose the application for a prov. order for E.L. being made by the Sunningdale and District E.L. Co., on the ground that the company would not undertake to supply the whole of the parish.

Continental Notes.—Italy.—A company has been formed under the auspices of the Tranentola (Potenza) municipality to install E.L. into the town. About 600 H.P. is to be obtained from the River Caolo.

The Campagna (Salerno) Council has decided to put down and work an installation for the town.

A scheme presented by Messrs. Asquini & Crisanti for the electric lighting of Genzano (Potenza) has been approved by the Town Council.

At Trani, the municipal authority has resolved to take over the public and private electric lighting of the town. Difficulties have, however, arisen between the Council and the company over the interpretation of the law governing the purchase.

A company has just been formed in Milan with the title La Società Elettrica Suburbana Milanesa to undertake the electric lighting of the little towns of Corsico, Cesano and Baggio.

La Societa Elettro-Chimica di Carema is putting down a plant to utilise the water of the River Rova in the Province of Piemonte, in the generation of electrical energy.

Darlington.—We regret that under these notes in our issue of December 15th, we were in error in stating that the net loss on the electricity and tramways undertakings of Darlington for the past year amounted to £1,400. This sum is not an actual loss for the past year, but an estimated loss for the present year, and it is on the tramway undertaking only.

Dorking.—A correspondent states that with the consent of the B. of T., the U.D.C. proposes to transfer its E.L. powers, duties, liabilities, and works to Messrs. Edmundson's Electricity Corporation, Ltd., for a period of 25 years from May 19th, 1903. The Council is to have the option of purchasing the undertaking at the end of 7, 10, or 14 years, or any subsequent year.

The U.D.C. gives notice of its intention to transfer its prov. order to Edmundson's Electricity Corporation.

Dundee.—Mr. H. Richardson, the burgh electrical engineer, has prepared a report in regard to extending the municipal electricity supply, which deals with:—(1) The putting down of more plant at the present station and more L.T. feeders; and (2) erecting a new H.T. generating station at Stannergate, at a cost of about £75,000, with sub-station distribution. He favours the adoption of the latter scheme.

Dunfermline.—The T.C. is still considering the question as to whether it will accept the Fife E.P. Co.'s terms for bulk supply. The E.L. Committee has instructions to still keep up the negotiations.

Faversham.—Arising out of the recent County Court action, the T.C. has decided that in all cases where in any quarter the amount of charge for energy for lighting for a larger consumption, shall come to less than the amount of charge for the actual consumption, the consumer shall have the right to be charged as if he had, in fact, consumed the larger amount, and be allowed the discount appropriate to such higher consumption. This is the privilege which the consumer sued, fought for in the County Court, but on the question of law he lost the case.

The T.C. has also lowered the price of energy for power to 2d. per unit up to 1,000 units, with a discount of 25 per cent. beyond that quantity.

Fraserburgh.—The Consolidated Pneumatic Tool Co. has offered terms to the U.D.C. for the lighting of the town by electricity, as follows:—The Council to pay £4,000 to meet the cost of installing the additional plant required and to pay the company 2d. per unit for the first two years and 1¾d. thereafter, and also expend £4,000 in laying the necessary mains.

Frimley.—The York Town and Blackwater Gas Co. has asked the U.D.C. to consent to the company applying for a prov. order to supply electricity.

Glasgow.—A Sub-committee was appointed in October last, to consider the question of providing additional generating plant to meet the increasing demand for electricity supply. On the 15th ult. the chief engineer, Mr. W. W. Lackie, submitted a report. He stated that, including the two 4,500-H.P. turbo-generator extensions which have just been installed at a cost of £130,000, the Corporation has now about 27,000 H.P. of plant. The demand during the present winter was estimated at quite 24,000 H.P., and in consequence, should one of the larger sets break down, supply would be defective. The engineer having been asked if larger sets than those just installed at Port Dundas could not be put down, plans and estimates have been got out accordingly. Sufficient space is available at Port Dundas for the addition of four 4,500-H.P. sets or three 7,500-H.P. sets. The report states that in the year 1910, the capital expenditure involved, if the smaller sets were put in, would be about £480,000, whereas with the larger sizes it would be £600,000, with a decrease also in interest, sinking fund and depreciation costs on the smaller sizes. From an engineering point of view the larger-sized plant would encroach on the switchboard gallery already erected, and it would be necessary to install larger or different boilers. Another point against putting in large units was that a breakdown would be a more serious matter. Continuing, Mr. Lackie stated that if these extensions were carried out, in 1910 the plant installed would total 54,000 H.P. in the different stations. It would then be time enough, he considers, to think over the installation of plants of 7,000 or 10,000 H.P. and any other extensions of buildings at Port Dundas or elsewhere might be designed to this end. The whole of the foregoing is based on the assumption that the increase in demand remains normal. In October last, the Extensions of Mains Sub-Committee reported that applications for a fortnight represented over 500 H.P.; this was exceptional, but nevertheless it was an indication of what might occur in the future. If the smaller sets are decided upon, it is proposed to install two in 1907 and two in 1909, and the cost of this plant alone is estimated at £65,288; or if the 7,500-H.P. sets were put down, two of which would probably be erected in 1907, and the third in 1910, the cost would be £73,605.

In regard to this question of future supply, the manager of the tramways department has intimated that that department would not be able to continue the supply of energy either to St. Andrew's Cross Station or to Waterloo Street sub-station after the winter of 1906-7; and possibly the supply to the French Street sub-station after the winter of 1907-8, would have to be discontinued, as all the current generated at the Pinkston power station would, after the latter date, be required for tramway purposes. Existing arrangements for these supplies must terminate at the end of the periods referred to. In consequence Mr. Lackie states that in addition to what is recommended above, it will be necessary to put down another turbine-driven generator of 4,500 H.P., making three in all, with boilers, economisers, &c., together with motor-generators and switchboards, and that this set should be put down at the St. Andrew's Cross station, as the cost of laying down the necessary H.T. main from that station to the French Street sub-station, would be about £12,400, compared with £22,400, the cost of laying such a main from Port Dundas. He estimated the capital expenditure on the plant, main, and buildings, at £35,500, making the total expenditure on additional plant and buildings to meet the demand of the winters of 1906-7 and 1907-8, £275,500. The sub-committee, considered the report, and resolved to recommend (1) that the engineer be authorised to obtain and submit offers for a third turbine generator of 4,500 H.P., with boilers, economisers, &c.; (2) that specifications for the necessary motor-generators and switchboards, &c., relative to the turbine generator above referred to be advertised for; and (3) that the engineer be authorised to obtain and submit offers for the completion of the second chimney at the St. Andrew's Cross station.

Finally, the Committee agreed to recommend (1) that in the meantime two additional turbine-driven generators of 4,500 H.P. each (one to be put down at Port Dundas station, and the other at St. Andrew's Cross station), with relative boilers, economisers, &c., be provided, and that offers be obtained therefor; and (2) that the engineer be authorised to prepare specifications for the necessary additional motor-generators and switchboards, &c.

It was also decided to recommend that application be made to the Secretary for Scotland for consent to borrow a further sum of £300,000 for electric light purposes.

Hapton.—The offer of Messrs. Simpson Bros. to supply electricity to the district, on terms 5 per cent. cheaper than the Burnley Corporation, has not been accepted by the ratepayers, who held a special meeting to consider the lighting question.

Kingston-on-Thames.—The T.C. has resolved to reduce the price of energy for power, cooking and heating to 2d. per unit after March next.

London.—Poplar.—An explosion occurred recently in an E.L. distributing box in West Ferry Road, Millwall, and a person passing at the time was burnt about the face and head.

Lambeth.—According to a return presented to the B.C. at its meeting on the 21st inst., the total cost to the 17 boroughs which opposed the Supply of Electricity Bills last session was £6,898, made up as follows: Administrative County Bill, £4,935; County of London Bill, £618; City of London Bill, £613; East London, &c., Bill, £339; Charing Cross Bill, £267; North Metropolitan Bill, £123.

Paddington.—The tender of the Metropolitan Electric Supply Co. to carry out an E.L. installation in the new Town Hall buildings for £636 has been accepted.

Lower Bebington.—The B. of T. has threatened to revoke the U.D.C.'s E.L. order, which has cost the Council £150.

Menai Bridge.—The U.D.C. has been asked by the National Electric Construction Co. to support a scheme to supply the Anglesea side of the Menai Straits with electricity.

Nottingham.—The P.C. has asked the Woolwich B.C. upon what terms it will supply energy to the parish.

Prestwich.—The Salford Corporation has quoted prices for lighting the public street lamps by electricity, and the U.D.C. has appointed a committee to consider the matter.

Rostrevor.—At a recent ratepayers' meeting it was resolved to recommend the Sanitary Committee to adopt the E.L. scheme submitted by Messrs. Curran Bros., of Belfast.

Sheffield.—The Sheffield Chamber of Commerce recently forwarded a copy of a resolution to the Corporation, stating that it had received a deputation from the Sheffield Electrical Contractors' Association on the subject of municipal trading as carried on in the electrical fitting and wiring department of the Corporation. The Chamber recorded its disapproval of the Council's carrying on this department with public funds. The matter has been referred to the E.L. Committee.

Sheerness.—The Admiralty has decided that the E.L. and power installation at Sheerness Dockyard, which was postponed by order a few months ago, is to be taken in hand without delay. The work is to be carried out by private contract.

Sutton Coldfield. — Another nicely printed and interesting little pamphlet has been received, this time from the engineer and manager of the Sutton Coldfield electricity department.

Torquay.—By a majority of one vote the Corporation has decided not to entertain the question of disposing of its electrical undertaking.

Upholland.—The U.D.C. recently approached Wigan T.C. with reference to a supply of electricity, but Wigan has replied that as the U.D.C. has not obtained a prov. order, nothing can be done.

Walthamstow.—A writ has been served upon the Council for an injunction in respect of an alleged nuisance at the electric lighting station. The clerk has been directed to defend the action.

Wantage.—A fire occurred recently at the Wantage Engineering Co.'s Works, but the E.L. installation fortunately sustained no damage.

Yardley.—The U.D.C. has decided to apply to the B. of T. for a further prov. order for E.L., which will enable the Council to transfer its powers to a company or public authority.

TRAMWAY AND RAILWAY NOTES.

Altrincham.—The U.D.C. has memorialised the B. of T. for the grant of a prov. order for the revival of the powers granted to the Council by the Tramways Order, 1904.

Bath.—The new Midland Bridge was opened on the 12th inst. by Alderman Taylor, chairman of the Electric Traction Committee. The bridge is of fine proportions, and supersedes a smaller one. The Bath Electric Tramways Co. contributed £11,000 towards the cost.

Birkenhead.—With regard to the opposition of the T.C. of Birkenhead to the action of the Mersey Railway Co. in starting a motor-'bus service to feed the railway traffic, referred to in last week's issue, matters at Birkenhead have reached an interesting stage. A special meeting of the Council was held on Tuesday to discuss the situation, and a resolution was passed to take legal proceedings against the Mersey Railway Co. to restrain the latter from running motor-omnibuses within the borough. Dr. Pearson said that the receipts from the Birkenhead tramways amounted to £50,000, and it was estimated that the loss which would be sustained by the tramways through the motor-'bus service would be one-eighth of the revenue. From the ferry receipts, which amounted to £25,000, the loss would also be one-eighth, making a total of £9,425, which would mean a rate of 4½d. on the town. If the reduction were only one-sixteenth, it would amount to £4,713, equal to a 2¼d. rate. With the extra cost of repairing the roads, through wear by the motor-'buses, the estimated total loss would be £11,000, which would mean a 6d. rate. Mr. Robinson reminded the Council that they held £5,000 in ordinary stock and £30,000 in debentures in the company.

Bury.—The T.C. is promoting a Bill in Parliament providing for the construction of new tramways which will connect up with those in the borough of Heywood in Rochdale Road and with those of Ramsbottom in the Walmersley Road. The total length of the new tramway is a little over three miles.

Colne.—The Colne and Trawden Light Railway has been completed, and on Thursday last week Colonel Druitt, R.E., of the B. of T., inspected the last section at Trawden, which is constructed partly on the public highway and partly on land acquired by the company. The line, which is 5¼ miles long, extends from a junction with the Nelson tramways through Colne to Trawden.

Continental Notes.—France.—Arrangements are being made for the transmission of electrical energy from the generating station of the Compagnie La Volta, near Moutiers, for motive power for the Lyons tramways. The power is furnished by a waterfall about 90 metres high, giving 14 cubic metres of water per second, and capable of supplying 12,000 H.P. The generating works, which have just been constructed by Messrs. Soprani et Basso Jean, contractors at Moutiers, are built for a power of 10,000 H.P., but only 6,000 H.P. will be used at the start. Four dynamos will be worked by the water-power, the hydraulic works for which have been carried out by Bonnet, Bonnet Spazin et Cie., of Lyons. The power will be transmitted to Lyons, in the form of direct current, by means of two copper wires, 9 millimetres in diameter, and it is estimated that only 10 per cent. will be lost on the way—that is to say, that 5,400 H.P. will be available at Lyons. The posts, of first quality fir from the Black Forest, are placed at a distance of about 40 metres from each other, and are deeply planted in the soil in a foundation of cement. There are 12,000 posts on the line, and the total cost of each post, including transport, erection, wires and all accessories, will be 72 fr. Two telephone wires will be placed alongside the transmission cable, one direct from works to works and one to various points on the line, for notification of breakdowns, &c. The line will be unique in the world, and is to cost nearly 5,000,000 fr.

Greece.—It is proposed to substitute electricity for horse traction on the Athens tramway system, and for steam traction on the Athens-Phaleron line. Large quantities of new rolling-stock will be required.

Switzerland.—The proposal for a railway through the Bernese Alps is becoming more and more defined. A Swiss contemporary, quoting from a report of the Department of Public Works of the Canton of Berne, states that, according to the memorandum of the international experts, Messrs. Colombo, Garnier & Pontzen, the Cantonal Committee received in 1904 from the Paris bank, Loste et Cie., in the name of a firm of contractors, an offer relative to the execution of financial and technical studies for the piercing of the Bernese Alps. The Committee accepted this offer, and in December, 1904, a contract was entered into for the presentation of the complete project. On October 3rd of this year the firm Loste et Cie. presented their plans and estimates for both steam and electric exploitation. Independently of these proceedings, the Committee has appointed Mr. A. Zollinger (the engineer for the Simplon Railway) to examine the question and submit plans for electrical exploitation.

Italy.—The Société du Tramway Rome-Civita Castellana has formulated a project for the extension of the electric railway from Civita Castellana to Viterbo. The line will be 42·5 kilometres long, and will connect with Falleri, Fabbrica, Corchiano, Vignanello, Vallerano, Canapino and Cagnaia.

The Commune of Varese has approved of subventions for the construction of an electric tramway between Varese and Brinzio, and for the extension of the Varese to Lake Varese line as far as Sesto Calende.

On November 12th last a meeting was held at the Chamber of Commerce at Lecco for the purpose of proposing to the Government that the system of electrical traction at present in force on the Valtellina line should be extended to the Lecco-Milan, Lecco-Bergamo and Ponte San Pietro-Usmate lines. More than 200 representatives of the provinces of Milan, Como, Bergamo and Sondrio attended, and, after having decided that the potentiality for traffic of these lines should be increased to render them capable of dealing with the increased Milan-Bergamo-Lecco-Valtellina trade, it was agreed that, considering that only a portion of the available hydraulic power is utilised for the Valtellina line, that the inevitable increase of traffic consequent on the change will give a corresponding stimulus to the revenues of the State, and will also increase the well-being of the people, and that the Government has promised from time to time to carry out this work, the meeting should urge the Government to undertake without delay the application of electrical traction to these lines.

(*Continued on page* 1059.)

THE SINGAPORE ELECTRIC TRAMWAYS.

The newly-equipped tramways in Singapore may, with the exception, perhaps, of that thriving enterprise in Calcutta, safely claim to be the largest and most up-to-date system east of Suez.

The buildings in Singapore, like those of other places in the Far East, range from substantial brick and stone structures to the rudely made huts of the native Malays. From the illustrations given herewith it will be seen that the streets are for the most part broad, straight and level, thus being admirably adapted for electric tramways.

The total population is approximately 250,000, which, besides Europeans, includes Eurasians, Chinese, Malays, Indians, Japanese, and many others.

Singapore is situated almost on the equator and suffers but little variation in temperature all the year round; the vegetation is, of course, of a tropical character.

The City of Singapore (or Sincapore) was founded in 1819 by Sir Stamford Raffles. In 1824 the British Government, purchased by treaty from the then Resident Officer or chief, called the "tumangong," for 60,000 Spanish dollars (£13,500) and a life annuity to the Sultan of Johore and his resident officer, of 24,000 dollars (£5,400), the sovereignty and fee simple of the island, as well as all the seas, straits and islands to the extent of ten geographical miles around; in 1830 it was made the capital of the Straits Settlements, superseding Penang, and to-day it is undoubtedly the most important trading centre in the south-east of Asia.

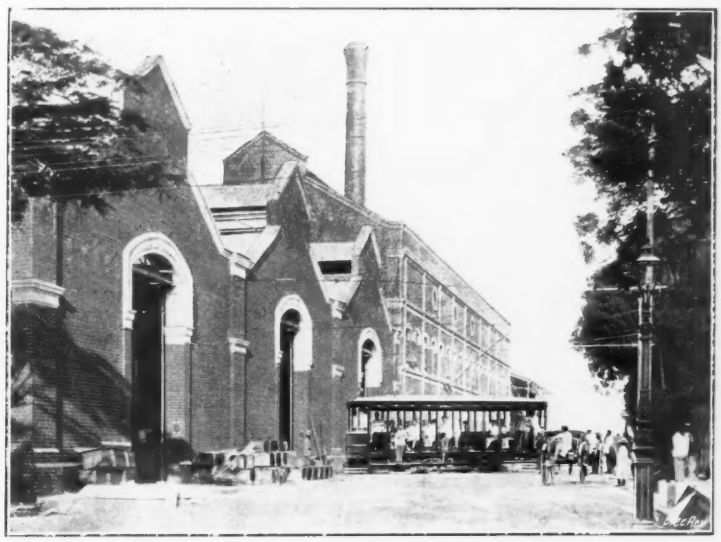


Fig. 1.—View of the Singapore Power Station and Car-Shed.

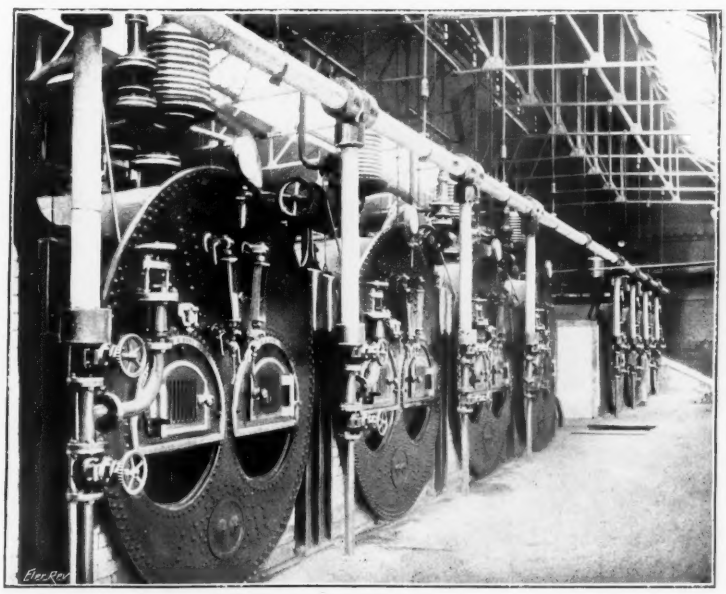


Fig. 2. The Boiler Plant: Singapore.

The construction of the tramways was authorised by an ordinance passed by the Legislative Council of the Straits Settlements in 1902: the promoters of the scheme were the Association General, Ltd., London, and the East India Construction Syndicate, Ltd., London, was formed for the purpose of carrying out the construction of the tramways.

The consulting engineers to the company are Messrs. Alfred Dickinson & Co., of Birmingham and London, who superintended the carrying out of the work, for which the contractors were Messrs. Dick, Kerr & Co., Ltd., of London and Preston.

The contract included the construction of a bridge over the Kalang River, in addition to the tramways.

The work was commenced in July, 1903, and the first section of the line was opened for traffic in July, 1905.

The total length of the tramways is 16 miles of route, the length of the single track being about 26 miles 4 furlongs. The track is laid to metre gauge, with rails of the girder type weighing 95 lb. per yd., and the rail joints are welded by the "Thermit" process. During the initiation of the scheme considerable discussion took place as to the advisability of having welded joints, the question at issue being, of course, the variation in the temperature; it was finally decided, however, that this difficulty was of too slight a nature to affect the joints after they had been securely welded together by this special process. In addition to the welded joint, a single 000000 s.w.g. copper bond is provided at every joint, thus ensuring perfect electrical conductivity.

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The routes in the centre of the city, and those running to the docks, are for the most part double track, with centre-pole construction, while the two routes leading north and north-east along the Serangoon and Gelang Roads respectively, are single lines with passing places, and are equipped with side-pole construction

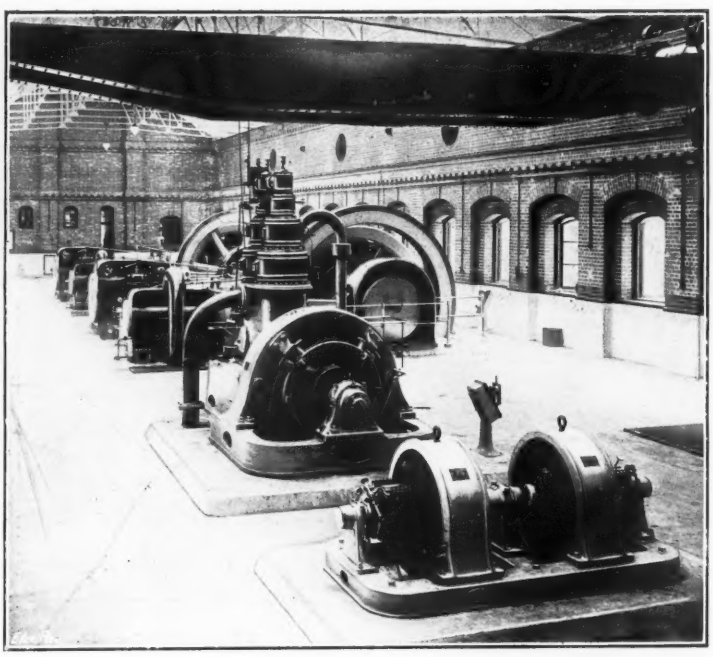


Fig. 3.—View in the Engine Room; Traction Plant in the Background

The permanent way throughout is of very substantial construction. The rails are laid on a longitudinal concrete sleeper 8 in. deep by 18 in. in width. The flange of the rail is embedded in the concrete to a depth of 2 in., and, consequently, there is a solid bed of concrete 6 in. deep under the rails, which are tied at intervals of 8 ft. The road surface up to the rail level has been made up with macadam, rolled and consolidated in the usual way.

The overhead construction consists principally of side and centre-pole construction, and also some two miles of span wire construction. The poles are of mild steel, 28 ft. 3 in. in length, and embedded 6 ft. in the ground, in a solid block of concrete. On the centre poles the lengths of arms are 2 ft., while those on the side poles vary in length according to the distance from the pole to the track.

The trolley wires, which are not necessarily over the centre of the track, the possible variation being about 10 ft., are divided into half-mile sections by means of section insulators. At each of these points, the main feeder cables are tapped and energy is led to the trolley wires by means of 37/16 rubber-covered cables, which are carried up the inside of the poles and along the side of the bracket arms. A lightning arrester is provided in each section pillar, as is also a telephone giving direct communication with the power house, and to guard against the tropical storms which are so prevalent in Singapore, the overhead system is additionally protected by heavy lightning arresters at every half-mile of wire; these are fixed on the poles in cast-iron boxes and are connected directly to the trolley wire.

The whole of the feeder cables were supplied by Messrs. Callender's Cable and Construction Co., and laid by them on their solid bitumen system.

The system of feeders has been arranged with due regard to future requirements, as it is generally anticipated that within the near future the traffic will rapidly increase, both as regards passengers and the conveyance of goods.

The generating station and car-shed occupy a position near the Rochore Canal, from which source water is obtained for condensing purposes. The depôt buildings comprise the engine room and basement, boiler house, car-shed, machine shop, carpenters' shop, paint shop, smithy, offices of the general manager and his staff, and the usual out-buildings.

The engine room is 190 ft. long × 48 ft. 9 in. in width, and contains two 500-KW. traction sets, one steam lighting set, one motor-generator lighting set, and the necessary switchgear.

The boiler house contains eight Lancashire boilers, arranged in two batteries of four boilers each; each boiler is capable of evaporating 6,000 lb. of water per hour, with a working pressure of 175 lb. per sq. in. Feed water is supplied to the boilers by four feed pumps (two to each battery); these are of the duplex compound non-condensing type, taking water either from the hot well or a storage tank. There are two "Green's" economisers, each containing 228 tubes; one economiser is situated at either end of the boiler house. The chimney stack, which is of steel, is 135 ft. in height, and 7 ft. internal diameter, and is a notable landmark for many miles around.

The traction engines were built by Messrs. Yates & Thom, Blackburn, and are of their well-known horizontal cross-

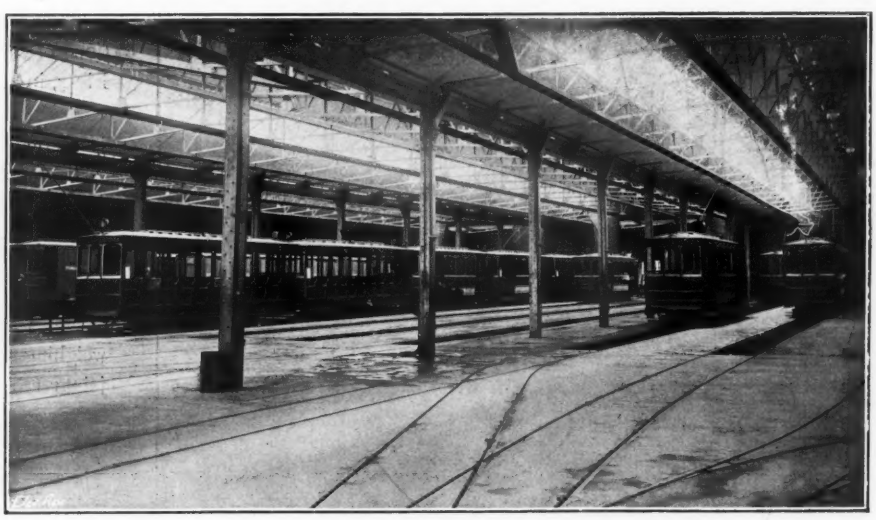


Fig. 4.—The Car Depot, Singapore.

compound condensing type, running at 100 r.p.m.; each is capable of giving a maximum output of 927 B.H.P., with a steam pressure of 165 lb. per sq. in. at the cylinders. Each engine is provided with a Worthington surface condenser, but may be worked either condensing or non-condensing. The condensers are installed in the

basement, as are also all the steam pipes and other usual accessories.

The generators are of the Dick-Kerr continuous-current multipolar type, compound wound, mounted on the shaft between the H. and L.P. sections of the engine. Each machine is designed to give a normal output of 500 KW. with a pressure of 550 volts, and to run separately or in parallel. They are in every respect in accordance with the firm's standard practice. The magnet frame is of cast-iron, the pole-pieces being built of laminated steel and cast into the magnet frame. The commutation is sparkless at all loads, and the windings are so arranged as to give a 10 per cent. rise in the E.M.F. from no load to full load. The lighting sets are for lighting the city and depôt by means of incandescent and arc lamps, and include one 150-KW. Dick-Kerr generator, running at a speed of 350—400 r.p.m., the dynamo of which is designed for use either as a compound or shunt machine, and is coupled to a "Willans" triple-expansion condensing engine with extension base; also a 50-KW. Dick, Kerr motor-generator set, shunt wound, designed to give a normal output of 100 amperes at 500 volts, and a maximum of 115 amperes at 550 volts, and two balancers of the same firm's make, for use in conjunction with the above lighting dynamos, for 500 volts pressure.

The switchboard was built by the contractors, and is composed of 15 panels, each supported independently on an iron frame. The board consists of a main station panel, two generator panels, five feeder panels, one B. of T. panel, and six other panels for lighting, &c.

The car-shed, 212 ft. in length × 138 ft. in width, is built to accommodate 84 cars, inspection pits for which are provided under each track.

Fig. 5.—Street Scene in Singapore: Showing the Single-deck Cars.

Fig. 6.—View on the Track: Keppie Road.

The rolling-stock consists of 50 passenger cars, three bogie motor goods vans, 15 four-wheel goods vans, and 15 four-wheel goods wagons. The passenger cars are divided into two distinct types, 30 being of the single-deck, single-truck, open type, to seat 32 passengers, and 20 single-deck, single-truck, combination type, to seat 40 passengers. The whole of the rolling-stock was built by the United Electric Car Co., of Preston. The car-bodies are mounted on Brill 21 E trucks, and each is equipped with two D.K. 25 B traction motors; the latter are of the four-pole, series-wound, single reduction type, capable of giving for one hour 25 B.H.P. The controllers are of the same firm's standard D.B. 1 form "C" patent metallic shield blow-out pattern, of the series-parallel type.

The cars are fitted with Hudson & Bowring lifeguards.

The three bogie motor goods vans are each mounted on Brill 27 G trucks, the equipments being of the D.K. 25 B quadruple type, with the D.B. 1 form "C" controllers. They are intended for a double purpose, namely, conveying goods and hauling goods trucks, the general arrangement of the body being such as to provide a self-contained van with divided sliding doors on each side, which may be securely locked up, and a vestibule canopy at each end as the platform for the drivers. The 15 goods wagons are equipped in a similar manner to the passenger cars; they are 12 ft. in length and 6 ft. 6 in. in width. These wagons are for general use for the conveyance of various classes of goods up to six tons in weight; the frames are made of mild steel channels, stayed by longitudinal and cross stays, knees and gusset plates; the side of each wagon is provided with strong hinges. In order to protect the goods from the weather each wagon is supplied with a detachable light angle-iron frame, upon which a tarpaulin is spread the full length of the car at a height of 7 ft. from the flooring of the wagon. They are, in construction, similar to the goods wagon described above. Each van is fitted with double sliding doors, and is the same size as the goods wagon.

The successful completion of this interesting scheme adds one more to the numerous Far Eastern undertakings, for which Messrs. Dick, Kerr & Co. have been responsible.

THE WEDNESBURY ELECTRICAL UNDERTAKING.

The Wednesbury Corporation obtained its provisional order in 1899, an agreement having been previously entered into with the Midland Electric Power Co.

The arrangement provides for the Corporation distributing electricity to consumers in Wednesbury, the energy being purchased in bulk from the company in the form of two-phase current at a pressure of 200 volts.

The Corporation's sub-station contains transforming plant to convert from two-phase to continuous current, which is supplied to the five feeding points of a distributing network covering some 3½ miles of the principal streets of the borough. The Corporation's mains are complete in themselves, and are so arranged that at any future date they may be supplied from a separate works, should that become advisable. It may here be mentioned that both the two-phase and continuous current systems of distribution were very carefully considered, and the latter was decided upon notwithstanding the additional expenditure necessitated by the transforming plant, so that full advantage could be taken of the maximum demand system of charging (for the supply in bulk) and also to give the most convenient form of supply to the consumers.

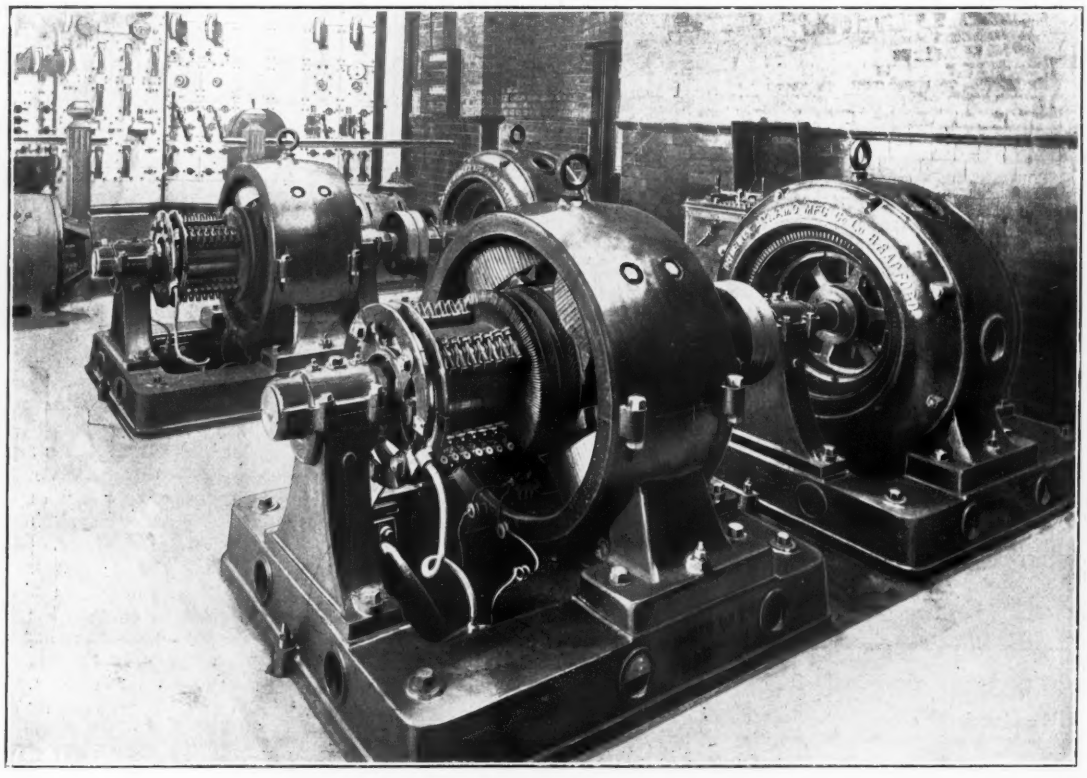
The sub-station buildings consist of the following: A generator room with switch gallery, an accumulator room, workshop, office, test room and stores. The buildings are arranged so that they may be easily extended: and in the case of the office building, provision has been made so that another floor can be added at any time with little or no alteration.

The transforming plant includes two motor-generators, manufactured by the Phœnix Dynamo Manufacturing Co., Ltd., of Bradford. These each consist of a two-phase induction motor coupled to a direct current generator, which is capable of delivering 300 amperes, at a pressure of 250 volts. The starting gear is fixed on to two special pillars adjoining the machines.

The battery consists of 117 cells, and has a capacity of 325 amperes for three hours. The containing cases are constructed entirely of lead, and each cell contains 27 plates: the positive plates are of the Planté type and the negative of the pasted type. The cells have been supplied and erected on heavy pitch pine stands by the British Accumulator Co., Ltd., of Westminster.

The battery is worked in conjunction with a Highfield booster, manufactured by the British Westinghouse Co., Ltd. The booster dynamo is capable of a maximum back boost of 75 volts, during the charging of the battery, and is capable of keeping the pressure practically constant on charge or discharge, automatically, within a limit of 30 volts difference of battery and line voltage, under all conditions of load (up to 325 amperes) and battery voltage.

The exciter is direct coupled to the booster, and the machine may be driven by either a continuous current motor of 30 H.P., or a two-phase motor of similar size. The continuous current motor is connected to the booster through a clutch, and the two-phase motor is similarly connected to the continuous current machine. These clutches enable the following arrangements to be used:—(1) Two-phase motor driving continuous current machine as a dynamo, booster disconnected; (2) two-phase machine driving booster through D.C. machine shaft, the latter machine idle; (3) the same as (2), but continuous current machine being run as a generator as well; and (4) continuous current machine only, driving the booster.



The Wednesbury Corporation's Sub-station, showing P.D.M. Motor-generators, &c.

In addition, a portable "milking" booster has been provided, consisting of a 200-volt two-phase motor coupled direct to a shunt-wound dynamo, capable of delivering 150 amperes at 6 volts.

The switchboard, which consists almost entirely of metal and marble, is arranged in a "bay" form. The central portion is reserved for the two-phase feeder gear, and the direct-current main ammeter, voltmeter and time-piece. On the left side of the bay the direct-current feeder panels are fixed, and on the right, the machine panels.

The switch gallery also contains the starting pillar of the booster. Ample space has been allowed behind the board, where, in addition to the switchboard connections, the main two-phase and direct-current meters are installed.

The switchboard is arranged to control the following:—The duplicate two-phase "receiving" mains, three motors

(two main and one booster); a spare panel is allowed for an additional machine: five direct-current feeder and two spare feeder panels, two main dynamo and two booster panels on the direct-current side, one spare panel being allowed for each.

A system of subways leads from the switchboard to the machines, battery, &c., and to the street, for conveying the connecting cables. The switchboard was built by Mr. W. Sanders, of Wednesbury, the instruments being of the permanent magnet edgewise and sector types, and mostly by Nalder Bros. & Thompson.

The mains consist of two-phase twin concentric, ·3, ·3 and ·45 sq. in. lead-covered "receiving" cables (connecting the Corporation's sub-station with the Power Co.'s sub-station); concentric lead-covered direct-current feeder cables, and single lead-covered cables for the distribution network. The distribution is carried out on the two-wire system, the pressure of supply being 230 volts. All the cables are laid in wooden troughs, filled in solid with bitumen and protected by hard burnt tiles. Generally where there are tramway lines, and in important streets, the distributing mains are laid on both sides of the roadway under the footpaths, but in the less important streets they are on one side of the road only. The cables were supplied by Messrs. W. T. Glover & Co., Ltd., and are of their well-known diatrine paper-insulated type.

The charges for the supply are as follows:—Lighting, 6d. and 2d. per unit on the maximum demand (one hour) system; power, 3d. and 1½d. per unit, or a flat rate of 1½d. per unit in the daytime, and 3d. during lighting hours.

An important point in connection with a distribution undertaking such as this, is that there is no risk of an excessive cost of production in the early years. The charge for electric power in bulk to the Corporation is 3d. for the first hour of maximum demand for each day, and ·825d. per unit for all further supply. The losses due to transformation and distribution appear principally in units at the lower charge, and similarly in the accumulators the losses are entirely low rate units. Although the maximum demand system is used, yet owing to the diversity factor, the total maximum load of the Corporation is, of course, less than the sum of each individual consumer's maximum demand during each quarter. Further, the accumulators reduce the Corporation's maximum demand on the Power Co. In an undertaking of this nature the increase in the Corporation's capital charges as the load increases will not be heavy.

A few figures as to the results of 18 months' working may be of interest. The consumers number about 90, and the connections have reached the equivalent of 5,258 8-C.P. lamps, including 28 H.P. in motors; and a further 596 lamps of 8-C.P. equivalent have been applied for in addition.

A noticeable point has been the even pressure, which has rendered the use of Nernst lamps very satisfactory, and it has thus been possible to compete successfully with incandescent gas lighting in the borough.

The technical negotiations with the Power Co. were carried out by Mr. F. J. Warden-Stevens, of Westminster, who has acted as consulting engineer to the Corporation. Mr. T. H. M. Swinburne acted as clerk of works. The undertaking has been carried on for 18 months under the instructions of the consulting engineer, and the position of resident engineer is held by Mr. W. Fennell.

TRAMWAY AND RAILWAY NOTES.

(*Concluded from page* 1054.)

Huddersfield.—At the meeting of the Huddersfield T.C. on the 20th inst., Mr. Ald. T. H. Moore and the Mayor criticised the action of the tramway employés in handing in their notices. Mr. Moore said that if the men had been advised by their union the strike would not have occurred.

Hythe (Kent).—The T.C. has taken the opinion of the Parliamentary agents concerning the legality of the offer of one of the promoters of tramway schemes to pay a certain sum simply for the Council's consent to the application. The opinion is that the Council can only take the money for improvements and street widenings carried out.

Liverpool-Southport Electric Railway.—The special motor carriage built by the Lancashire and Yorkshire Railway Co. to maintain a through service between Southport electric railway and the south end of Liverpool, over their own lines to Seaforth, and thence over the lines of the Overhead Railway, has now covered 1,000 miles of journeys to and fro over the route. The tests have proved so satisfactory that single carriages of this description will shortly be put into service. These special cars have accommodation for both first and third-class passengers, and for smokers and non-smokers, having seats for sixty passengers.

London.—UNDERGROUND ELECTRIC RAILWAYS.—A certain modification is proposed in the arrangements made between the B. of T. and the L.C.C. in 1904 on the subject of precautions against fire in underground electric railways. Since that time the chief officer of the Fire Brigade has had an opportunity of inspecting an underground line built in accordance with the requirements of the B. of T. As a result, the officer is of opinion that the minimum requirements should be amended in certain respects, as regards the provision of fire hydrants, water and sand buckets, &c., and extincteurs.

L.C.C.—On Wednesday last week Col. Yorke, on behalf of the B. of T., inspected the length of tramway which has been constructed from the Highgate Archway to the Archway Tavern to link up the tramway systems of the Middlesex and London County Councils. This short length of tramway has been constructed by the L.C.C. on the overhead system, and will be leased to the Metropolitan Electric Tramways, Ltd., and worked by them in continuation of the line from Whetstone to the Archway, which they already lease from the Middlesex County Council. The new line was opened for public traffic on Friday last.

New York.—The *Times* New York correspondent states that August Belmont & Co. have purchased control of the Metropolitan Street Railway system from Mr. Thomas F. Ryan. The deal includes the purchase by Mr. Belmont and his associates of all the stocks and bonds of the Metropolitan Securities Co. and the Metropolitan Street Railway owned by Mr. Ryan and his associates. It will result in the absorption of the Metropolitan Street Railway system by the Interborough Rapid Transit Co., which already holds the lease of the elevated railway system and the working contract for the subway. In other words, Mr. Belmont and his associates gain an absolute monopoly of passenger transportation in Manhattan and the Bronx—underground, surface and overhead. Mr. Belmont now controls the greatest traction monopoly in the world.

Walthamstow.—It was decided by the U.D.C. on Friday to apply to the B. of T. to extend the time fixed by the Walthamstow and District Light Railway Order, 1903, within which the light railways are to be completed, for a period of three years.

TELEGRAPH AND TELEPHONE NOTES.

Brighton.—The T.C. has decided to apply to the L.G.B. for a loan of £2,000 for connecting new telephone subscribers to existing spare plant, pending the settlement of the negotiations now in progress with the post office.

Far-Eastern Cables.—A banquet was recently given at Cologne by the German-Dutch Telegraph Co. to celebrate the opening to traffic of the company's cable between Menado, Yap, Guam and Shanghai. In addition to the directors of the company, there were also present representatives of the German and Dutch Governments and of the allied concerns, the German Atlantic Telegraph Co., and the Nordenham cable factory, which made the cable in question. State Secretary Kraetke, who delivered the first speech, gave a review of the political development of the scheme, and mentioned that he frequently had occasion to report the progress made to the Kaiser, who took great interest in the work, as also did the Queen of Holland. The Dutch Minister Fock observed that the Queen had expressed high satisfaction at the success of the enterprise, and had authorised him to present to the president of the board of directors (Herr Müller) the Commander's Cross of the Orange-Nassau Order. Herr Max von Guilleaume, in reply to kindly references to the work performed by the North German Marine Cable Works Co., of Nordenham, observed that he wished for further prosperity for the cable industry, with the prospect of the establishment of a German cable between the Fatherland and South America.

Germany.—The Imperial telegraph system will be appreciably extended in the coming year. According to a recent official notice, 1,590 new telegraph offices are to be opened. With few exceptions, the places to be connected are small country ones, which will be served by telephone, and become telephone stations as well, but there are several important lines.

Glasgow.—The National Telephone Co.'s switch-room plant at the Royal Exchange, which was destroyed by fire on 16th inst., was reopened on the 22nd, and it was expected that the service would be fully resumed at the beginning of this week.

Italy.—As mentioned in this column last week, the Minister of Posts and Telegraphs was act vely engaged in the purchase of the telephone lines at present worked by private contract. A special commission is at present calculating the value of the various lines as a basis for purchase. The Société Générale Italienne des Telephones and the Société des Telephones de la Haute

Italie are to renounce their rights at the end of a year, and to accept a sum based on the returns for the remaining years of the concession. By the purchase, the Government will appropriate:—The 15 city services of the Association Générale Italienne des Téléphones; the nine intercommunal lines of the same society; the nine city services of the Société des Téléphones de la Haute Italie; and the six intercommunal lines of the same company.

Leeward Islands.—The Acting Colonial Secretary of the Leeward Islands, in a recent report, states that the subsidies paid to the West India and Panama Telegraph Co. amount to £1,400 per annum, of which Antigua pays £500; St. Kitt's Nevis, £500; and Dominica, £400. There is no telegraphic communication with either Montserrat or the Virgin Islands. There are telephone services in the presidencies of Antigua, St. Kitt's and Dominica. In Antigua there are 150 instruments in use and 260 miles of wire; in St. Kitt's, 87 instruments and 253 miles of wire; in Dominica, 92 instruments and 280 miles of wire. In Antigua, receipts in 1904 amounted to £746, and expenditure to £711; in St. Kitt's, receipts £408, expenditure £456; and in Dominica, receipts £306, expenditure £1,396. This is the first occasion on which a surplus has been shown on the working of the Antigua telephone service. The expenditure in Dominica is somewhat large, owing to the extension of the system to the country districts.

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired.
Trinidad-Demerara (No. 1.)	Aug. 26, 1901	
Dominica-Martinique	May 7, 1902	
St. Lucia-Martinique	May 7, 1902	
Reissa-Issa (Yemen) Camaran	Oct. 22, 1902	
Cayenne-Pinheiro	Aug. 13, 1902	
Tarifa-Tangier	Jan. 18, 1904	
Closed { Vladivostock-Nagasaki	Feb. 7, 1904	
Closed { Port Arthur-Chifu	Mar. 7, 1904	
Jamaica-Colon	Jan. 5, 1905	
Cadiz-Tenerif	July 20, 1905	
Puerto Plata-Martinique	Oct. 30, 1905	
Landlines.		
Puerto-Barrios	Aug. 28, 1902	
Kertch-Soutchoum	Sept. 27, 1904	
Communication with Brazil *via* Galveston	July 18, 1905	

Venezuela Cable Dispute.—The *Morning Post* Washington correspondent states that the Franco-Venezuelan dispute is rapidly becoming a farce, but at the same time it is a fine object lesson in the efficacy of the Monroe doctrine in protecting South American dictators from European wrath. France, he says, hinted to the Washington Government that she would like to make an "Omelette à la Castro." The Washington Government said, in substance, that it had no objection if, in making the omelette, France would break no eggs!

A Reuter message states, according to a *Herald* Caracas telegram, that President Castro, on 13th inst., withdrew not only the objectionable phrase in the Venezuelan counter protest to which France objected, but the entire Venezuelan protest, thus rendering possible a settlement of the dispute with France.

Wireless Telegraphy.—The *Standard* New York correspondent reports that the North German liner *Bremen* received wireless messages from Nantucket when she was 631 miles eastward, which continued until she was 319 miles eastward. From that point messages were incoherent until within 30 miles of the position of the sunken lightship. The *Bremen's* inquiries regarding the incoherency of the messages were answered by foul language, suggesting the intervention of some rival agency, which the officers of the *Bremen* declare they will further inquire into.

CONTRACTS OPEN AND CLOSED.

OPEN.

Aberdeen.—January 6th. Six tramcar top-deck covers for the Corporation. See "Official Notices" to-day.

Croydon.—January 9th. The Guardians are inviting tenders for electric fire alarms at the Infirmary. Specifications, &c., from Mr. Henry Berney, architect, 104, George Street, Croydon (deposit, £3 3s.).

Grimsby.—January 5th. 500-KW. engine and dynamo, boiler, switchboard, and other plant and cables for Corporation electricity department. See "Official Notices" December 8th.

Islington.—January 1st. Suggestions for purification of water are invited by the B.C. electricity department. See "Official Notices" December 8th.

Marylebone.—January 10th. House service fuse boxes, also stores, for the Borough Council. See two "Official Notices." December 22nd.

Pontypridd.—January 1st. Cable conduits for the U.D.C. See "Official Notices" December 22nd.

Pontypridd.—January 15th. Eight double-deck tramcars for the U.D.C. See "Official Notices" December 22nd.

St. Pancras.—January 9th. Arc lamps, columns and cradles for the B.C. See "Official Notices" December 22nd.

Southend-on-Sea.—January 25th. One 500-KW. steam dynamo for the Corporation. See "Official Notices" December 22nd.

CLOSED.

Glasgow.—Messrs. Malcolm & Allen have received the contract for the electric lighting of Pollokshields Library, their offer amounting to £179 18s. 6d.

The sub-committee on works of the Electricity Committee, having considered the tenders received for providing and erecting (1) three sets of turbine-driven generators for Port Dundas and St. Andrew's Cross stations; (2) nine motor-generators and accessories for sub-stations; and (3) high tension and low tension switchboards and instruments for sub-stations, agreed to recommend the acceptance of the following offers:—

Willans & Robinson, Ltd., for the turbine-driven generators	£43,717 0 0
British Westinghouse Co., Ltd., to the extent of seven sets of motor-generators and double-balancing attachments	17,850 0 0
Bruce Peebles & Co., Ltd., to the extent of two sets of motor-generators and double-balancing attachments	5,000 0 0
British Westinghouse Co., Ltd., for high-tension switchboards and instruments	867 11 0
Ferranti, Ltd., for low-tension switchboards	1,398 0 0

The total amount of these offers is £68,832 11s.

The Tramways Committee has recommended for acceptance the following offers:—

Scrap lead.—William Stevenson & Co.
D.C.C. wire.—The London Electric Wire Co.
Oilskin suits.—Lewis's.
Springs.—L. Stearn & Co., and George Turton Platts & Co.
Electric lift for Coplawhill car works.—Turner, Atherton & Co.
1,000 13-mm. carbons for arc lamps.—Siemens Bros. & Co.

The contract for the boilers required in connection with the extensions of the electricity works at Port Dundas and St. Andrew's Cross stations was the subject of a spirited discussion at the T.C. The Committee, by a majority, recommended the acceptance of the offer of Messrs. Babcock & Wilcox, Ltd., for ten boilers, at £16,716. An amendment was that nine of the boilers be given to Babcock and Wilcox, and one boiler to the Stirling Boiler Co. Mr. Willock, the convener, in moving the approval of the minute, said that the contract had been carefully looked into, and although it appeared at first sight that the difference between the two offers was £2,000, after taking into account the extra cost of erection, and the extra cost necessary to equalise the amount of material offered in both cases, the difference between the two offers amounted to £629, which, spread over ten boilers, was really a very small amount per boiler. The department had already twenty boilers of the Babcock and Wilcox design and they had given every satisfaction. They were, naturally, anxious to continue with those if the price was any way reasonable, so as to have the advantage of the various economies which arose from uniformity of plant in the boiler house. Their engineer had estimated that there would be a saving of something like £210 per annum in fuel and repairs on the extra capital expenditure of £629. They were, therefore, of opinion that they were really accepting the lowest offer. Although material had risen in price since they last bought boilers, the quotation now recommended for acceptance was lower than the price last paid by he department to Messrs. Babcock & Wilcox for boilers. Mr. Alston moved that the minute be remitted back to have expert opinion on the boilers. Bailie R. S. Brown, in seconding, said he had consulted several eminent boiler makers, and their opinion was that the Stirling boiler was the better of the two. Mr. Wallace said that if they laid down the doctrine that only one firm could supply boilers to the Corporation they would greatly restrict competition. The Stirling boiler was considered in America to be one of the best boilers in the world. He denied that there would be any such saving with the Babcock & Wilcox boilers as Mr. Willock had suggested. He had estimated that they would save £70 a year on the ten boilers. That was very fine figuring. The Stirling Co. were prepared to guarantee that the boiler would come up to the standard laid down on the specification, and also to build in the boilers at the same price as the Babcock & Wilcox Co. Ultimately the minutes were sent back to the Electricity Committee for further consideration.

Ilford.—The U.D.C. has accepted the tender of Messrs. Johnson & Phillips, Ltd., for the supply of feeder cable, boxes, &c., at £1,689.

India.—*Indian Engineering* states that the tender of Messrs. T. E. Thomson & Co., of Calcutta, for the supply of electric fans and lighting equipment to the new Howrah station of the E.I. Railway has been accepted, the price being Rs. 20,000.

London.—Southwark.—The B.C. has accepted the tender of Messrs. Hammond & Champness, at £57 10s., for electric fittings for the stables. There were 12 tenders, ranging from that accepted to £123 11s. 5d.

Leyton.—The U.D.C. has provisionally accepted the following tenders:—

Stirling Boiler Co.—Two boilers, with superheaters.
Tudor Accumulator Co.—Storage battery.
Brush Electrical Engineering Co.—Two engines, with Mirrlees-Watson's condenser.
Midland Engineering Co.—Condenser water cooling-tower.
Mr. Boby.—Feed water heater and purifier.
Lancashire Dynamo & Motor Co., Ltd.—Reversible booster and motor transformer balancer with connecting apparatus.
Thermit, Ltd.—Welding and bonding tramway rails.
Troup, Curtis & Co.—Installation of electric light at Lea Bridge branch library.

Salford.—The Education Committee has accepted the tender of Mr. F. M. Burley, of Blackpool, for installing the electric light in the Secondary School and Pupil Teachers' Centre, at £168 17s. 6d.

Walthamstow.—The U.D.C. has placed an order with Messrs. Connolly Bros., for cables for wiring schools.

Warrington.—The Electricity and Tramways Committee has accepted the tender of Messrs. W. Rouse & Son, of Heckmondwike, for four car-top covers, at £280.

FORTHCOMING EVENTS.

Thursday, January 4th.—Rugby Engineering Society. Mr. F. R. Clough on "The Conversion of Mechanical into Electrical Energy."

At 8.15 p.m. Röntgen Society, at 20, Hanover Square. Presidential Address by Prof. F. Soddy on "The Present Position of Radio-Activity."

Saturday, January 6th.—I.E.E. (Manchester Students). Visit to the Chloride Electrical Storage Co.'s Works.

Tuesday, January 9th.—At 8 p.m. I.E.E. (Glasgow). Meeting.

Wednesday, January 10th.—At 8 p.m. Association of Engineers-in-Charge. Mr. F. Crawter on "Storage Batteries and their Application to Public Institutions."

Tramways and Light Railways Association. Mr. A. L. C. Fell "On Brakes."

Friday, January 12th.—At 7.30 p.m. I.E.E. (Manchester Students). Mr. J. C. Ward on "The Electrical Equipment of Automobiles."

At 8 p.m. I.C.E. (Students). "The Theory of Machines" by Prof. J. D. Cormack.

NOTES.

A Prosperous New Year.—The Electrical Review desires to wish all of its friends everywhere a time of great prosperity during the coming year. May there be unprecedented progress in every department of British electrical industry at home and abroad!

The Electrical Trades Benevolent Institution.—In a recent issue we made brief reference to this new effort of the National Electrical Manufacturers' Association. It may interest our readers if we give a short summary of the rules of the Institution, so that its objects may be better understood.

The Institution will be supported by donations, annual subscriptions and bequests. Its object is to grant pensions and to dispense temporary relief to deserving and necessitous persons, who are, or have been, engaged in the electrical trade in the United Kingdom, or to their widows and families. Applicants must have been subscribers for at least five years, and have been engaged in the electrical trade, and must not be less than 50 years of age, unless it shall be proved to the satisfaction of the Committee that although less than that age they are incapacitated from earning a living by reason of mental or bodily infirmity: or widows of subscribers who are in necessitous circumstances during widowhood.

The Committee may make immediate grants of money to relieve temporary or urgent necessity, or amongst the children or widows of those who are, or have been, engaged in the trade; but no grant shall exceed the sum of £20.

The affairs of the Institution will be managed by trustees and a Committee of not more than 30 (five to form a quorum), to be elected by the donors and subscribers at the annual general meeting. One-third of the Committee are to retire each year in rotation, but they shall be eligible for re-election.

A general meeting of donors and subscribers is to be held annually in the month of March or April, at which the general business of the Institution will be transacted. No member whose subscription is in arrear shall be eligible to vote.

The amount and term of an annuity shall be determined by the Committee.

Subject to the rules providing for appointment otherwise than by election, all pensioners shall be elected by the votes of donors and subscribers to the Society immediately after the annual general meeting in each year.

Upon the death of any pensioner the Committee may grant any sum not exceeding £7 for or towards funeral expenses.

Upon the death of a pensioner leaving any child or children who were dependent upon him or her, and who are unprovided for or insufficiently provided for, an annuity of such amount as may from time to time be determined, not exceeding £6 per annum, may be granted by the Committee to each such child, to continue until he or she attains the age of 14 years, or for any less period, but so, nevertheless, that the total amount of the annuities payable under this rule to the children of any one pensioner at any one time shall never exceed the annual sum of £50.

A single payment of £1,000 shall entitle the donor to found and name a permanent pension of £40 per annum with the nomination without ballot, during his lifetime. The nominees of special pensions must in all cases be eligible under and subject to the existing rules of the Institution.

Only subscribers and donors to the funds shall be entitled to attend and vote at general and extraordinary general meetings.

Donations on behalf of a firm, corporation or association shall entitle them to one vote for every £1 given, or donations of £100 shall entitle them to nominate a Governor for 10 years, with 10 votes per annum.

Donors contributing £100 in one payment shall be Life Governors, and shall be entitled to 10 votes each year.

There are, of course, many details in the rules for which we are not able to spare space, but anyone who feels particular interest in the matter could doubtless obtain a complete copy by communicating with Mr. Walter Davenport, the Association's secretary, at Ridler Place, Holland Street, Blackfriars.

A Short Caused by a Balloon.—It is reported from Vienna that a short circuit was caused by a balloon on the evening of December 7th in the village of Zistel, not far from the paper and celluloid works at Potoshmuhle and Krummau. It appears from Austrian accounts that the occupants of the balloon brought the latter nearly to the ground, and the peasants who caught the anchor rope were requested to post a correspondence card. The card having been handed over, the balloon was released, but at first it did not rise any higher, and in the darkness the aeronauts did not appear to notice the overhead electrical conductors carrying current at 15,000 volts from the generating station of Messrs. Ignaz Spiro & Sons. The anchor rope caught the lightning conductor wire, which was thrown down on to the high-pressure mains, and in a moment a heavy short circuit took place. A further result of the "fireworks" was experienced by the before-mentioned paper and celluloid works being deprived of power for working the machinery, the interruption in the supply extending over five hours. In the meantime the balloon had risen and passed away. The occupants of the balloon, as shown by the postcard, were members of the Augsburg Aeronautical Club, which, it is stated, is to be made responsible for the expenses of the interruption in working.

Water-power in Switzerland.—The Swiss Federal Council has approached the long-debated question of the conservation of the national supplies of water-power in a form that was entirely unexpected. Desirous of having ample water power for the production of electrical energy for the projected working of the railways by electric traction, the Federal Council has prepared a scheme which contemplates the "prohibition of the export of national water powers," or in other words, the stoppage of the electrical transmission of power over the frontier. The preamble of the scheme does not suggest an absolute prohibition once and for all time, but rather that the utilisation of Swiss water powers should be assured for the interests of the country and the population. Thus in so far as the power is not required in the country, it will be available for use in neighbouring lands, but where needed in Switzerland it should be at the disposal of the native population. In subjecting to the approval of the Federal Council proposals for the utilisation in other countries of the product of Swiss water power, the scheme foresees the possession of a weapon for fighting the competition of foreign industries favoured with lower wages and more satisfactory conditions of sale. The legislative project seems, to some extent, to be aimed at Germany, and in this connection a Basle newspaper asks what would happen if Germany were to retaliate by placing an embargo on the export of coal to Switzerland. The answer, which is not given by the Swiss newspaper, is that the French coal producers would be glad and willing to increase their exports to Switzerland. But suppose Germany were to forbid the transmission (export) of electrical energy from Rheinfelden and Lauffenburg across the frontier into Switzerland? This problem has apparently not yet been taken into account, and it is really a question whether the present scheme has been brought forward with the serious belief that it will be approved by a majority of the legislators and the population of Switzerland.

Welding with Acetylene Gas.—Engineer Memmo publishes in the *Bulletin of Italian Engineers and Architects* a praiseworthy article on the welding of metals with acetylene gas. The employment of acetylene for the generation of heat is of very recent date, and shows great promise of entering successfully into the field of practical work. Acetylene can, in a small space, produce most powerful effects by extremely simple means, and should be used in the future in place of the hydrogen flame.

With the oxyhydrogen flame it is usual to calculate a weight of 89·6 grammes per cubic metre, and a resulting heat during combustion of about 3,090 calories. A cubic metre of acetylene gas weighs about 1,165 grammes, developing in combustion over 14,000 calories. The theoretical proportions required to assure complete combustion are 2½ volumes of oxygen per volume of acetylene. The flame has a centre of azure blue surrounded by an intensely heated, almost colourless, zone. The temperature of combustion is very difficult to determine on account of the extremely rapid diffusion of the heat; the most recent experiments place it at 3,800° to 4,000° C., as against 2,500° to 3,500° for the hydrogen flame. The jet becomes brilliantly luminous whenever the acetylene gas is in excess of the proportion of oxygen, and this gives sufficient indication to the operator to enable him to determine practically

the proportions necessary to give the best effect, by slowly increasing the oxygen until the outer sheath of the flame becomes practically colourless.

The cost of acetylene gas is given at 1½ lire per cubic metre, and 3 lire per cubic metre for oxygen; this, in the proportions used for welding, works out to 2·6 lire, or, approximately, 87s. per 1,000 cb. ft. On this basis the cost for ordinary work would come out at about 6d. per hour.

The first mixing tubes employed consisted of the usual simple arrangements, but the results were imperfect. Experiments were then tried by passing the two gases through a single tube, containing diaphragms of porous material, before the nozzle was reached. Again the result was unsatisfactory, on account of frequent stops necessary to change these diaphragms, and the liability of gas taking small fragments of the porous material with it, and thus blocking the nozzle. Recently the plan has been adopted of passing the two gases through several extremely fine tubes, contained in one large tube, beyond the T piece connected to the separate holders, and this has afforded excellent results, when working with an initial pressure equivalent to 1 or 1½ metres of water.

When intending to use this apparatus, rubber tubes are connected between the receptacles containing the oxygen and the acetylene, both of which must be provided with pressure regulators, and on the acetylene tube there should also be provided a non-return valve, so that under no circumstances can the greater pressure of the oxygen gas cause it to invade and become mixed with the acetylene in the generator or holder of the latter; such a mixture might be extremely dangerous. The spear-like flame should have a diameter of 3 to 4 millimetres, and a length of 10 to 15 millimetres.

If there is too much acetylene, there will be a luminous white sheath due to the free carbon. With an excess of oxygen, the flame becomes too clear, and there is the probability of frequent extinction of the flame.

With care in the quantitative adjustment of the gases, an extremely neat weld can be effected in about one-fourth of the usual time. Experiments made on welded steel show that the results are as strong as those obtained by electrical welding.

Examples are given of practical work done in repairing boiler plates by welding in new portions, and in repairing a vulcanising machine worked at a pressure of 5 atmospheres. Other important work, for which it is indicated that the flame may be extremely useful, is the welding up of a system of tram rails. The high temperature effects the fusion of platinum and all the other more refractory metals. Whilst approaching the high temperature of the electric arc, acetylene admits simple means for the regulation of the working temperature.

The Rusting of Iron.—The *Journal of the Chemical Society* issued in October last, includes a paper on the above subject by Prof. Dunstan, Dr. Jowett and Mr. Goulding. The paper contains a full account of some investigations begun by Prof. Dunstan several years ago, first mentioned in a lecture delivered by him before the Royal Artillery Institution at Woolwich in 1898, and afterwards briefly referred to in the *Proceedings* of the Chemical Society during the year 1903. The results of the research completely upset the favourite view as to the cause of the rusting of iron, and are therefore of considerable importance to all engineers. Based on some experiments carried out by Crace Calvert a good many years ago, and fortified by the approval of Prof. Crum Brown, most of our text-books have stated that iron rusts in damp air only in presence of carbon dioxide, otherwise called carbonic acid gas, the latter body being a necessary re-agent in order that the liquid water permanently in contact with, or temporarily condensing upon, the metal might become acid, and might dissolve the iron just as aqueous hydrochloric acid does. Hence we have always imagined that three separate substances must approach a piece of iron simultaneously before it can be oxidised, viz., oxygen, liquid water and carbon dioxide; and it has, therefore, followed from this, that any arrangement capable of keeping one of these materials at a distance, should be competent to preserve the metal from corrosion. This idea has, indeed, been apparently borne out by the manner in which iron can be prevented from rusting if moisture, or the condensation of water vapour upon it, is avoided; and by the fact that articles kept in contact with slaked or preferably quicklime in powder (an absorbent of carbon dioxide) remain bright.

It now appears, however, that the presence of carbon dioxide is not necessary during the process of rusting, but only that of oxygen and liquid water. In contact with dry oxygen or carbon dioxide, or a mixture thereof, iron does not rust; nor does it, if the gases are moist, provided always that condensation does not occur. The actual method whereby ordinary rust is formed, appears to involve the temporary production of hydrogen peroxide, thus, $Fe + O_2 + H_2O = FeO + H_2O_2$. Half the hydrogen peroxide reacts with the ferrous oxide to yield "rust," a body having the formula $Fe_2O_3(OH)_2$; while the other half acts upon a fresh quantity of iron in the same fashion as the mixture of oxygen and water. Alkalis and alkaline salts, such as sodium, potassium and ammonium carbonate, calcium hydroxide (slaked lime), ammonia, &c., prevent rusting, not because they withdraw the carbon dioxide from the sphere of action, but because their presence leads to the establishment of conditions in which the production of hydrogen peroxide is inhibited. When zinc "rusts," the presence of hydrogen peroxide can be detected, but that is not possible in the case of iron. Rusting may be somewhat assisted or hastened by the carbon dioxide of the air, but the quantity at hand is so small that the gas can only play a small and subordinate part in the process. The rusting of pure iron is not an electrolytic phenomenon, and no hydrogen is set free.

Load Factor and Operating Costs.—The generation of electrical energy entails several considerations which are somewhat peculiar to the industry itself. One of these is the question of load factor. A proper study of the effect of load factor in any individual plant is indispensable if the commercial value of the concern is to be a maximum. The whole matter resolves itself into an effort to flatten the load curve. Several means have been adopted towards this end, all more or less successful. Various systems of charging have been originated in order to discourage load during the peak hours and encourage the use of current during times of slackness. It must be remembered, however, that for every area there is a certain maximum load factor which no amount of juggling will improve. Further improvement can only take place by so arranging the plant as to generate with the greatest economy. The much-discussed battery here steps in. Of course, the efficacy of the battery is often limited by its smallness, and because a small battery does not give the result that its installation promised, it is often assumed that the principle is not so good as its supporters would have it, when, as a matter of fact, a larger battery would have made all the difference. A battery, moreover, in addition to its usefulness as a flat-iron, provides a certain amount of insurance against collapse of supply, and in all cases the amount of latitude in the operation of the plant which results from its use has a beneficial effect, by no means negligible, on the staff itself.

There are probably several concerns in the United Kingdom whose generating plant is installed in two or more stations. The advantages that very often accrue from operating these stations in conjunction, where possible, with a view to economy of running is well brought out by Mr. L. P. Crecelius in a recent paper read before the American Railway Mechanical and Electrical Association at Philadelphia. He mentions a large light railway system—the United Railways Co. of St. Louis—running two plants of 13,950 KW. and 7,000 KW. capacity and two smaller ones. The bus-bars of the larger stations were coupled to the smaller ones by means of trunk mains of sufficient section to carry the load of these smaller works during the hours of light load, allowing for a reasonable loss of pressure. Heavier loads were negotiated by running up the smaller stations on to the bus-bars as required, so keeping constant load in the main centres for a longer period of the day, the efficient running of the smaller plants being a subsidiary consideration. The result has been a saving of £36 per day on the total cost of operation with a load factor in the larger stations of 57·7 per cent., as compared with 50·23 per cent. when running isolated. The article is illustrated by curves obtained from the plant, and the use of the battery in levelling the load is demonstrated.

London and Brighton Motor Way.—This scheme, of which particulars have been published, includes the establishment of a generating station for the supply of electrical energy on the banks of the River Wandle, near Waddon Mills, Croydon.

Electric Power: A Royal Commission?—The *Morning Post* says that in view of the magnitude of the issues involved in the schemes of the London County Council and private companies for the supply and distribution of electric power in the Metropolis and over a large area outside, it is anticipated that one of the early administrative acts of the new Government, will be to recommend the appointment of a Royal Commission to consider and report on this important question.

Glasgow and West of Scotland Technical College.—The new technical college, which has been erected at a cost of over £200,000, was formally opened on Thursday last week by Captain Sinclair, M.P., Secretary for Scotland. The college is the oldest in the kingdom, and with its new buildings the largest in Great Britain. The electrical engineering staff consists of:—Prof. M. Maclean, M.A., D.Sc., F.R.S.E., M.I.E.E.; J. Kirkwood, B.Sc., A.G.T.C.; R. B. Burrowes; Andrew N. Aikman, A.G.T.C.; Wm. Allan; Thos. Hetherington; W. B. Hird, B.A.; J. J. Hunter Johnstone, M.A., A.M.I.E.E.; John M. Hossack.

Our American Contemporaries.—The McGraw Publishing Co., of New York, announces that from January 1st, 1906, the *Electrical World and Engineer* (weekly) and the *American Electrician* (monthly) will be consolidated under the name of the *Electrical World*. Those who still desire a monthly paper will receive the first issue of each month.

L.C.C. Car Speeds.—On 20th inst. a London County Council tramcar driver was summoned at Greenwich for exceeding the speed of twelve miles an hour between Canal Bridge and the Greenwich borough boundary. It was said that he covered 220 yards in twenty-six seconds, which was at the rate of over 17 miles an hour. The defendant said he had been driving only a fortnight, and did not know the speed. Mr. Baggallay said it was a dangerous rate, and fined the defendant £3 and 2s. costs.

Appointments Vacant.—Junior technical assistant for Northampton Institute electrical engineering department; engineer fitter for the Camberwell Infirmary (45s.); station and mains superintendents for the Calcutta Electric Supply Corporation, Ltd.

Will.—Sir H. C. Fischer, late Controller of the Telegraph Department, who died on November 30th, left estate of the gross value of £50,061 1s. 2d.

Electric Shock Fatality.—It is reported that Alexander Melville, a young engineer, took hold of a high tension switch at a Glasgow electric power station on Wednesday, thinking the current had been cut off, and received a 6,500-volt shock, killing him instantly.

OUR PERSONAL COLUMN.

[The Editors invite electrical engineers, whether connected with the technical or the commercial side of the profession and industry, also electric tramway and railway officials, to keep readers of the ELECTRICAL REVIEW *posted as to their movements.]*

Central Station Engineers.—On 22nd inst. Mr. G. CHARLTON, managing engineer of the Kidderminster and District Electric Lighting and Traction Co., Ltd., was the recipient of a handsome smoker's cabinet and accessories as a token of the esteem in which he has been held by the staff and employés. Mr. J. E. Cowderoy made the presentation, and thanked Mr. Charlton for the very kind consideration he had shown the employés during his time with them, and assured him that Mr. Arthur Charlton, his brother, would receive the same loyal support as had been given him. Messrs. Steadman and Titcumb bore out these remarks. After the presentation Mr. Charlton invited the staff to supper at his residence. Mr. G. Charlton leaves Kidderminster on January 1st to take up a similar appointment at Merthyr Tydfil, and Mr. Arthur Charlton, of the Leicester Corporation electricity works, will succeed him.

Mr. J. E. EDMUNDSON has resigned the position of manager of the Scarborough Tramways Co., and has been appointed resident engineer to the electric lighting works in Grantham and Stamford. Mr. Edmundson is also to be responsible locally for constructional work in Scarborough. Mr. W. E. NICOLL, secretary to the Tramways Co., has been appointed manager at Scarborough.

Tramway Officials.—The Tramways Committee of Bolton T.C. has appointed Mr. JOHN BARNARD as assistant traffic manager, at a salary of £160 per annum, rising by £10 a year to £200.

General.—Mr. D. G. SUTHERLAND, who for the last five years has held the post of chief engineer of Messrs. Bruce Peebles & Co.'s contract department, resigns his position at the end of December to become partner in the old established firm of engineers, Messrs. Mitchell Graham & Son, 46, Buccleuch Street, Edinburgh. Electrical and mechanical engineers are invited to forward lists and catalogues to him at that address.

Mr. ALAN R. FENN has left the Lancashire Electric Power Co. and taken up a position on the sales staff of the Key Engineering Co., Ltd., of Manchester.

Mr. T. L. REED COOPER, M.I.Mech.E., M.I.E. & S., is leaving Glasgow in order to take up the general commercial managership of the Johnson-Lundell Electric Traction Co., Ltd., at their works, Southall, Middlesex, on January 1st, 1906. He has resigned the post of manager of Messrs. J. H. Holmes & Co.'s business in Scotland, which he has held for more than 10 years.

As we go to press various reports are in circulation stating that Mr. C. T. YERKES is in a very critical condition.

Obituary.—Electric tramway men throughout the world will learn with regret of the serious loss their class has sustained in the sudden death of one of the most noted tramway managers of this country—Mr. CHARLES REVILL BELLAMY, A.M.I.C.E., the city lighting engineer and general manager of the Liverpool Corporation Tramways. Death occurred on Saturday last, a few minutes before midnight, at his residence, Camden Lodge, Edge Lane, Liverpool. According to evidence given at the inquest on Tuesday, Mr. Bellamy on December 12th, in trying to avoid stepping upon a rope lying on some steps leading into the basement of his house, fell, spraining his ankle and injuring the calf of his leg. He kept to his room, and seemed to be progressing satisfactorily, but suddenly collapsed on Saturday night. A post-mortem examination showed that death was due to the clotting of an artery from the heart to the lungs, accelerated by the injury to the leg. A verdict of "Accidental death" was returned. Mr. Bellamy was related to Sir George Livesey, chairman of the South Metropolitan Gas Co., and received an early training under Sir George, who was then engineer-in-chief of the company. In 1877 Mr. Bellamy was appointed chief engineer of the Norwich station of the British Gas Light Co. In 1882 he removed to Liverpool to become assistant gas and meter inspector. In 1894 he was appointed superintendent of the lighting department at Liverpool, and in the following year became city lighting engineer. Mr. Bellamy's services to the city in connection with the lighting department have been somewhat eclipsed by his services in connection with the change from the old horse tramways to the now extensive electric tramways in Liverpool. The electric car system was inaugurated in November, 1898, and in December of that year, owing to the breakdown in health of the then manager, Mr. J. O'Neill, Mr. Bellamy was appointed acting manager of the tramways. In January, 1899, the Tramways Committee appointed him manager of the tramways department. The extensive developments of the electric tramways in Liverpool, which left the city at the close of 1904 with a capital expenditure on tramways account of £1,916,257 14s. 11d.; with 103 miles of tramway track; with a stock of 494 electric cars; with a total revenue in 1904 of £557,888 13s. 10d., and with a gross profit of £190,043 12s. 8d., were carried out under Mr. Bellamy's personal superintendence, as were also the important duties of organising the working, and of introducing improvements in the later working, and advantages affecting the large staff of employés, which now number 2,300. Mr. Bellamy was 49 years of age, and has left a widow and a family of seven children, one of his sons, Mr. L. C. F. Bellamy, being general assistant in the tramways office. A touching circumstance in connection with Mr. Bellamy's death is that he had had prepared a special "service" Christmas card which was issued on Sunday, thanking the numerous employés on the completion of the seventh year of his control of the Liverpool tramways, for the assistance which each one had given in building up and maintaining the great business with which they were connected.

NEW COMPANIES REGISTERED.

Buenos Ayres Grand National and La Capital Tramways Joint Committee, Ltd. (86,923).—This company was registered on December 20th, with a capital of £1,000 in £1 shares, to acquire and hold for an estate equivalent to fee simple, or on lease or tenancy or otherwise, any lands, buildings and property in the Argentine Republic, to erect workshops, repairing and stabling sheds, buildings, plant and appurtenances, to control the use, administration and maintenance of such workshops, &c., to adopt agreements (1) between La Capital Tramways Co., Ltd., of the first part, the Buenos Ayres Grand National Tramways Co., Ltd., of the second part, La Capital Traction and Electric Co., Buenos Ayres, Ltd., of the third part, and F. Thursby, for this company, of the fourth part; and (2) with La Capital Tramways Co., Ltd., of the first part, F. H. Jackson and W. Trotter of the second part, the said W. Trotter and R. Fleming of the third part, La Capital Traction and Electric Co., Buenos Ayres, Ltd., of the fourth part, the Buenos Ayres Grand National Tramways Co., Ltd., of the fifth part, and the said F. Thursby, for this company, of the sixth part, to acquire and carry out concessions for tramways, railways and other public works, to construct, equip and work tramways, and to carry on the business of tramway, railway and omnibus proprietors, carriers, electrical engineers and contractors, construction of power houses, dynamos, engines, batteries, lamps, motors, converters, meters and other electrical plant, suppliers of electricity for light, heat, and power, &c. The subscribers (each with one share) are:—J. I. Courtenay, 1, Essex Court, Temple, E.C., barrister; C. M. Rose, 3, Throgmorton Avenue, E.C., barrister; W. A. Paine, 14, St. Helen's Place, E.C., solicitor; H. M. Cohen, 14, St. Helen's Place, E.C., solicitor; T. F. Thomson, 62, London Wall, E.C., civil engineer; A. S. Jeeks, 24, Austin Friars, E.C. solicitor; F. Thursby, 62, London Wall, E.C., charter secretary; H. W. Johnson, 24, Austin Friars, E.C., solicitor. No initial public issue. The number of directors is not to be less than three nor more than five. The Buenos Ayres Grand National Tramways Co., Ltd., and La Capital Tramways Co., Ltd., may each appoint two directors, and the four directors so appointed may appoint a fifth. Remuneration as fixed by the company.

T. Hood & Co., Ltd. (86,900).—This company was registered on December 18th, with a capital of £2,000 in £1 shares (800 6 per cent. cumulative preference), to acquire the business carried on at 26, Bath Street, Bristol, as "Drewett & Hood," to adopt an agreement with H. Drewett and T. Hood, to act as factors and agents to manufacturing engineers, and to carry on the business of electricians, mechanical engineers, suppliers of electricity and gas for light, heat, motive power or otherwise, manufacturers of, and dealers in, apparatus used in connection with the generation, distribution, supply, accumulation and employment of electricity and gas, &c. The first subscribers (each with one ordinary share) are:—T. Hood, 41, Hampden Road, Knowle, Bristol, electrical engineer; H. Drewett, 58, Coronation Road, Bristol, electrical engineer; Mrs. E. C. Hood, 31, Hampden Road, Knowle, Bristol; Miss. A. Drewett, 58, Coronation Road, Bristol; C. S. Willis, 94, Coronation Road, Bristol, builder; W. M. Cleverdon, 60, Coronation Road, Bristol, coachbuilder; and W. V. Lawrence, 29, Clare Street, Bristol, chartered accountant. No initial public issue. The number of directors is not to be less than two nor more than five; the first are H. Drewett and T. Hood (both permanent subject to holding 100 shares); qualification of other directors, 25 shares; remuneration as fixed by the company. Registered office, 26, Bath Street, Bristol.

Q.C.E.D.A. Syndicate, Ltd. (86,794).—This company was registered on December 9th, with a capital of £60 in £1 shares, to acquire any existing or new patents and inventions relating to quick charging and efficient charging accumulators, and to carry on the business of manufacturers and sellers of such accumulators and of motors, motor-cars, motor-boats and all machinery and appliances connected therewith. The first subscribers (each with one share) are:—E. W. Whitehead, 46, Dover Street, W., gentleman; C. R. Whistler, 109, Lidbury Road, Notting Hill, W., assistant secretary; M. M. M. Adam, 90, Park Street, W. (late 3rd Batt. Royal Berks. Regiment); E. M. Whitehead, 36, Albemarle Street, W., surveyor; F. Paul, 32, Sinclair Road, W., gentleman; R. Wynter, 14, Argyle Mansions, Beaufort Street, W., gentleman; and H. V. Whitehead, 29, Brunswick Square, W., articled clerk. No initial public issue. Registered without articles of association.

Lens Lamp Co., Ltd. (86,774).—This company was registered on December 8th, with a capital of £60,000 in £1 shares, to take over the business carried on at 150, King's Cross Road, London, as the "Bohm Lens Lamp Co., Ltd.," to adopt an agreement with B.N.C., Ltd., and to carry on the business of lamp manufacturers, glass blowers, electricians, &c. The first subscribers (each with one share) are:—E. J. Watts, 7, Great St. Helens, E.C., clerk; H. Gibson, 8, Great St. Helens E.C., solicitor; T. H. Sidgen, Sefton Cottage, Forty Hill, Enfield, insurance agent; W. Eacott, 29, Powell Road, Clapton, N.E., gentleman; A. W. N. Stuart, 31, Carysfort Road, Clissold Park, N., accountant; C. T. Lissenden, 24, Arica Road, Brockley, S.E., gentleman; and R. J. Hawkins, 10, Soudan Road, Battersea Park, S.W., clerk. No initial public issue. The number of directors is not to be less than three nor more than seven; the subscribers are to appoint the first; qualification (except first directors), £250; remuneration, £100 each per annum (£50 extra for the chairman), and 5 per cent. of the profits available for distribution, divisible. Registered office, 7, Great St. Helens, E.C.

Eldon Electric Co., Ltd. (86,880).—This company was registered on December 16th, with a capital of £3,000 in £1 shares, to acquire and carry on the business of electrical engineers, importers, manufacturers' agents and dealers in all kinds of electrical apparatus, appliances and accessories carried on by A. G. Robson and R. Burdis, at Newcastle-on-Tyne, as "The Eldon Electric Co.," and to adopt an agreement with A. G. Robson, R. Burdis, A. A. Goldstone, M. H. Goldstone and J. H. Ward. The first subscribers (each with one share) are:—A. G. Robson, 8, Eldon Square, Newcastle-on-Tyne, electrical engineer; R. Burdis, 8, Eldon Square, Newcastle-on-Tyne, electrical merchant; W. A. Chandler, 10, Neville Street, Newcastle-on-Tyne, coal merchant; J. A. M. Collier, 185, Rodsley Avenue, Gateshead, electrical engineer; W. G. Batty, 2, Jesmond Dene Terrace, Newcastle-on-Tyne, coal merchant; J. Walton, 88, Bayswater Road, Newcastle-on-Tyne; and W. Coupland, 129, Windsor Avenue, Gateshead, clerk. No initial public issue. The number of directors is not to be less than two nor more than five; the first are A. G. Robson, managing director, and A. A. Goldstone (both permanent). If A. G. Robson retire from office, R. Burdis may succeed him. If the said A. A. Goldstone cease to hold office, the holders of shares Nos. 758 to 1,757 may appoint a successor; qualification, £200. Registered office, 8, Eldon Square, Newcastle-on-Tyne.

Thames Electrical Joinery Co., Ltd. (86,888).—This company was registered on December 16th, with a capital of £15,000 in £1 shares, to acquire the business of the Fire Prevention Building Co., Ltd., to adopt an agreement with the said company, and G. G. Smith, and to carry on the business of timber merchants, saw-mill proprietors, joiners, builders, contractors, engineers, manufacturers of, and dealers in, electrical materials, fittings and appliances, &c. The first subscribers (each with one share) are:—A. J. Lovelace, 85, Gresham Street, E.C., solicitor; F. A. Cordell, 19, Grovedale Road, Upper Holloway, N., clerk; G. W. Branch, 118, Clarence Road, Clapton, N.E., clerk; P. H. Goodwin, 12, Hayton Street, Chelsea, S.W., clerk; R. G. Commin, 96, Upper Tulse Hill, S.W., articled clerk; W. A. Richardson, 2, Lynton Road, W. Acton, accountant; and J. G. Main, 103, Malmesbury Road, Bow, E., clerk. No initial public issue. The number of directors is not to be less than two nor more than seven; the subscribers are to appoint the first; qualification (except first directors), £200; remuneration, £100 each per annum.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Perth Electric Tramways, Ltd. (55,935).—Issue on November 15th, of £600 debentures, part of series created December 22nd, 1903, to secure £50,000, charged on the company's undertaking and property, present and future, including uncalled capital, subject to £200,000 first debenture stock. Trustees: Lord Arthur Butler, 7, Portman Square, W., and J. S. Austen, 68, Dashwood House, E.C. Previously issued of same series: £39,000.

N. S. Electric Storage Co., Ltd. (London) (75,623).—Issue on November 15th of £4,000 debentures, part of series created August 10th, 1905, to secure £20,000, charged on the company's undertaking and property, present and future. No trustees. Previously issued of same series: £2,800.

Compagnie des Magnetos Simms-Bosch, Ltd. (60,925).—Formerly Automatic Magneto-Electric Ignition Co. (France and Belgium), Ltd.—This company's annual return was filed on November 2nd, when the entire capital of £15,000 in £1 shares had been taken up. £1,000 has been received. £14,000 is considered as paid. Mortgages and charges: Nil.

Musselburgh and District Electric Light and Traction Co., Ltd. (85,169).—A trust deed dated November 13th, 1905, to secure £60,000 debentures, has been registered. Property charged: The company's undertaking and property, present and future, including uncalled capital. Trustees: Sir Nathaniel Nathan, Kt., The Cottage, Edenbridge; and M. R. Pryor, 48, Leadenhall Street, E.C.

Telephos, Ltd. (81,111).—This company's statutory report, filed November 28th, shows 365 preference and 977 ordinary shares taken up out of a nominal capital of £10,000 in 8,000 preference shares of £1 each, and 40,000 ordinary shares of 1s. each; 10s. per share called up on 315 preference, £1 per share on 50 preference, and 1s. per share on 970 ordinary, resulting in the receipt of £256. No mortgages or charges registered.

Edison & Swan United Electric Light Co., Ltd. (18,984.)—This company's annual return was filed on November 3rd. Capital £941,090, in 150,000 "A" and 26,436 "B" shares of £5 each and 23,564 "B" shares of £2 10s. each, of which 99,261 "A" (£3 paid), 17,139 "A" (£5 paid), and 23,564 "B" (£2 10s.) shares have been taken up; £5 per share is considered as paid on 17,139 "A" and £2 10s. per share on 23,564 "B," making a total of £144,605 credited on shares issued as fully paid; £2 10s. per share is considered as paid on 89,261 "A" (£3 paid), and £3 per share on 10,000 of the same class, making a total of £253,152 10s. credited on shares issued as partly paid; £44,630 10s. (10s. per share) has been paid in cash on the above-mentioned 89,261 "A." Mortgages and charges: £399,576. The original capital was £1,000,000, which was reduced to above amount in October, 1904, by cancelling £2 10s. per share on 23,564 "B" shares. A resolution to further reduce the capital to £888,071 by cancelling an additional £2 5s. per share on the said 23,564 "B" shares (reducing their nominal value to 5s. each) was passed on October 30th last; but no order of Court sanctioning such reduction has yet been filed. A special resolution awarding the board 750 guineas extra remuneration for the year 1905, was confirmed on November 16th last.

Electric Supply Co. of Victoria, Ltd. (66,059).—This company's annual return was filed on October 27th, when 125,000 preference and 125,000 ordinary shares had been taken up out of a nominal capital of £300,000 in 150,000 preference and 150,000 ordinary shares of £1 each; £7 has been received and £249,993 is considered as paid. Mortgages and charges: £160,000.

Webster Electrical Engineering Co., Ltd. (Bradford), (83,637).—Issue on December 9th of £375 6 per cent. first mortgage debentures, part of series created February 28th, 1905, to secure £1,000, charged on the company's undertaking and property, present and future, including uncalled and unpaid capital (if any). Holder: F. W. Taylor, Newboult, Ivy House, Moorhead, Shipley. No trustees. Previously issued of same series, £625.

Electric Law Press, Ltd. (72,435).—Issue on December 8th of £700 7 per cent. debentures, part of series created November 9th, 1905, to secure £1,000, charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. No previous issue of same series. This series is in substitution for a series which is to be paid off.

W. T. Henley's Telegraph Works Co., Ltd. (13,795).—A trust deed dated November 24th, 1905, to secure £300,000 debenture stock, has been registered. Property charged: Certain land and premises in Woolwich, North Woolwich and Northfleet, and in the City of London, and the company's undertaking and other assets, present and future. Trustees: The Rt. Hon. Sir Alfred C. Lyall, G.C.I.E., K.C.B., 18, Queen's Gate, S.W.; and H. L. M. Tritton, 54, Lombard Street, E.C.

Guildford Electricity Supply Co., Ltd. (36,725).—£25,000 debentures, created 21st and dated November 30th, 1905, have been registered. Property charged: The company's undertaking and property, present and future, including uncalled capital. No trustees.

Electrolytic Alkali Co., Ltd. (64,360).—This company's annual return was filed on November 22nd, when 202,210 ordinary and 100,000 preference shares had been taken up out of a nominal capital of £500,000 in 300,000 ordinary and 200,000 preference shares of £1 each. £1 per share has been called up on 227,210 shares, and 75,000 are considered as fully paid.

Issue on Nov. 30th of £300 4½ per cent. first mortgage debentures, part of series created July 9th, 1904, to secure £50,000, charged on the company's undertaking and property, present and future, including uncalled capital. Trustees: Liverpool Mortgage Insurance Co., Ltd., 6, Castle Street, Liverpool. Previously issued of same series: £20,850.

Scottish House-to-House Electricity Co., Ltd. (29,232).—A mortgage or charge dated December 7th, 1905 (supplemental to and endorsed on a charged dated March 31st, 1904), securing a further £1,000 and 6 per cent. interest, has been registered. Property charged: The company's undertaking and property, present and future, including the Coatbridge and Airdrie undertakings, benefit of orders and of agreements for lighting and otherwise, uncalled capital and book debts. Holders: County of London Electric Supply Co., Ltd., Moorgate Court, E.C.

Dewhurst's Engineering Co., Ltd. (73,205).—This company's return was filed on October 24th, when 2,000 preference and 1,007 ordinary had been taken up out of a nominal capital of £10,000 in 2,000 preference and 8,000 ordinary shares of £1 each; £1 per share has been called up and £3,000 has been received. Mortgages and charges: £9,400.

Amazon Telegraph Co., Ltd. (44,532).—This company's annual return was filed on December 5th, when the entire capital of £250,000 in 25,000 shares of £10 each had been taken up and paid for in full. Mortgages and charges: £255,600.

Pacific and European Telegraph Co., Ltd. (36,683).—This company's annual return was filed on November 29th, when the entire capital of £100,000 in 10,000 shares of £10 each had been taken up, £4 per share had been called up, and £40,000 had been received. Mortgages and charges: £100,000.

Flather & Co., Ltd. (74,602).—This company's annual return was filed on October 27th, when 1,527 shares had been taken up out of a nominal capital of £3,000 in £1 shares. £27 has been received, and £1,500 is considered as paid. Mortgages and charges: £1,000.

CITY NOTES.

Isle of Thanet Electric Tramways and Lighting Co.

An ordinary general meeting of the shareholders of this company was held on Wednesday last week at Winchester House, Old Broad Street, Lord Arthur Butler presiding.

The Chairman, in moving the adoption of the report, said he regretted to have to report a serious decrease in the traffic receipts, which had amounted to £32,081 as against £35,005 for the corresponding 12 months—a decrease of £2,924. The lighting receipts had increased by £490, and the number of consumers, both in Margate and Broadstairs, showed a weekly increase, but progress was necessarily slow. The number of 8-c.p. lamps applied for and connected was 13,795—3,781 at Broadstairs and 10,014 at Margate. The total working expenses for the year amounted to £22,378 as against £24,128 last year—a decrease of £1,750. The only item of general expenditure showing an increase was that of accident insurance—£1,519. That was a very heavy item, but it was unavoidable. It represented the cost of fully insuring the company for the year against third party risks, and the expenditure had been justified, taking into account what the accidents of the past year would have cost the company had the directors not been able to effect this insurance. They were finding an economy in fuel by using a mixture of coke and coal, and a still greater economy would be made now that they were able to use Yorkshire coal instead of Welsh coal during the winter. During the year Mr. H. F. Parshall had made a very careful inspection of the works of the company, and he told the board at a recent meeting that, in his opinion, the whole of the plant and machinery, and the permanent way, was in a most satisfactory condition. Taking into acc unt the poor result of last year's working, the directors had waived more than half their fees. After paying all charges, there remained a balance of £1,047, which the directors proposed to carry forward. He was sorry that they were not in a position to pay the preference dividend up to September last. The general traffic of the year had been disappointing. Trade generally had not been good, and there was no doubt that the holiday makers, on whom they depended for their summer receipts, had not been able to make as much use of the tramways as they had hoped would have been the case. Unquestionably, however, the serious falling off in the traffic receipts was caused by the two unfortunate accidents which had occurred in the past year—one in May, and the second, and a more serious one, in August. Neither of these accidents would have happened had the ordinary printed rules of the company, a copy of which was supplied to every motorman, been obeyed. Those rules ordered that compulsory stops should be made at the top of Bellevue Road and Madeira Hill, at which places the accidents took place, so as to ensure the cars coming to a dead stop before descending those hills. In both cases, however, the rule was disobeyed, and the accidents were the result. The report of the Board of Trade inspector—Colonel von Donop—blamed the company for having allowed a driver of so little experience to have charge of a car which had to go up and down Madeira Hill. With all due respect to Colonel von Donop, he did not think that was a fair deduction from the evidence, as the directors contended that the training of the particular motorman, which had been gradually spread over the whole of the route since the end of April, should, in the ordinary course of events, have enabled him to drive over every part of the road with perfect safety. Seeing, also, that he had negotiated Madeira Hill at least 70 times before without accident or trouble of any kind, it did seem to them that the lack of training to which Colonel von Donop referred was not the cause of the accident, but that the real cause was the disobedience to orders, and neglect in making the compulsory stop at the top of the hill. In order, however, to secure the greatest possible efficiency in the working of the cars on Madeira Hill, they had now arranged that none but drivers of long experience on the road should take cars up or down the hill. It would be reassuring to the public to see from Colonel von Donop's report that the gradients on Madeira Hill "were not excessive, and, provided the brakes were in good order, there is no reason why a car should be allowed to get out of hand in descending them." The recommendations in the report were receiving the careful consideration of the directors; in fact, they had already taken steps to consult an expert electrical engineer on the subject, and were now awaiting his report. From time to time certain adverse criticisms had been made upon the management at Thanet, and one gentleman who held that view was Mr. H. F. Parshall, the eminent engineer, who was also a large shareholder. He (the chairman) invited Mr. Parshall to make an investigation on the spot, and, as a result, one of that gentleman's representatives made an exhaustive inquiry and report, and it was with no small satisfaction that he had heard from Mr. Parshall that—to use his own words—"the management at Thanet was as good as could be," and he added that he could find no fault. That testimony had given the board much satisfaction, bearing out, as it did, their high opinion of the capacity of their manager, Mr. Humphries, and his ability in dealing with a very difficult situation.

Mr. H. Brown seconded the motion, which was agreed to after some discussion.

Provincial Tramways Co.

The report for the year ended September 30th last states that net revenue received from the local companies has been £24,050 against £24,095 last year. There has been set aside for depreciation

£7,000, and the directors recommend a dividend on the ordinary shares of 4s. per share, making 7s. per share for the year. The balance to be carried forward will be £2,752. Through unforeseen difficulties in connection with the construction of the track and overhead work, and also in consequence of delay in the completion of the power station plant, the directors regret that their expectations that this undertaking would have been completed and working by electric traction in the spring of this year have not been realised; the lines are, however, now completed, and the machinery has been running for some short time with satisfactory results. It is hoped that an early date will be fixed for the Board of Trade inspection. The Bill in Parliament, for an extension to Privett station, and for power to supply electrical energy to a local railway (provided satisfactory terms can be made with that company for such supply), duly passed and received the Royal assent. In June last the directors issued a circular to the shareholders in order to elicit their views as to the desirability of writing off lost capital by reducing the nominal value of the ordinary shares of the company. The result was, out of 870 shareholders, 230, representing about 31 per cent. of the ordinary capital signified their assent; 105 shareholders, representing about 14 per cent., signified their dissent; and 535, representing about 55 per cent., did not reply. The circular stated that those shareholders who did not reply would be assumed to assent. The directors, therefore, conclude that a considerable majority of the shareholders are in favour of the reduction. The matter is somewhat complex, and requires that all the details shall be carefully worked out, as, if it were duly approved by the shareholders, it would afterwards have to be submitted to the Court for confirmation. The directors do not, therefore, propose to submit the matter upon the present occasion, but they have the scheme under careful consideration.

Mr. Andrew Beattie presided at this company's meeting on 21st inst., and the report recommending a dividend of 7s. per share for the year was adopted. It was stated that the receipts at Grimsby had been well maintained, but there had been some falling off at Plymouth. Unless the board were asked by the large preponderance of the shareholders to take steps in regard to the reduction of capital scheme, they would abandon it.

Costa Rica Electric Light and Traction Co.

The report for the year ended June 30th last states that the net earnings in Costa Rica amounted to £10,159 as against £9,155 in the previous year. A further issue of debentures to the amount of £5,000 was made during the year, in repayment of the balance of Mr. Keith's advances on capital account. The lighting concession under which the company is working in San José was dated to run out on December 31st next. A new concession of 50 years from January 1st, 1906, both for lighting and tramway, has been granted to the company by the municipality on equitable terms, subject to confirmation by the President of the Republic. The small plant at Cartiago, from which a very insignificant revenue was derived, has been disposed of to a local enterprise, and the proceeds are being devoted to improvements in the San José plant. A storage reservoir increasing the capacity of the Maria Aguilar River was completed in June last. As practically all the power at present at the company's disposal has been taken up, and the management is compelled to refuse new customers, it has become necessary to develop further water power and to install further machinery. Surveys have been made and estimates obtained showing that for a sum of £8,000 or £9,000 the lighting capacity on the Tiribi River can be considerably more than doubled. The directors propose to make an early issue of debentures for this purpose.

Diesel Engine Co.

Mr. C. C. Ellis presided at the fifth ordinary general meeting on 21st inst., and in moving the adoption of the report, he said that although he was not able to present as good a statement as last year, he hoped they would not feel that the company was, therefore, in a bad way. They had had rather a peculiar year. The last general meeting was adjourned for six months, and a committee appointed to consult with the directors as to bringing about an improvement in the management. During the six months that that committee was sitting the directors and the staff had a considerable amount of work to do which was not connected with the actual current business; but they had got over all this, and the recommendations of the committee had to a certain extent been adopted, so far as it was in the power of the present directors to adopt them. They had only just got over this hiatus in the affairs of the company when their manager, whose agreement had terminated some time previously, tendered his resignation, having first put forward certain terms to which the directors, in the interests of the company, felt they could not accede. They were fortunate in obtaining the services of Mr. Browett (their present manager), and since his appointment the orders coming in had increased very considerably; indeed, the orders which Mr. Browett had managed to get for the company were somewhat phenomenal as compared with those formerly received. From March 31st to date they had received orders for 5,635 h.p., as compared with 2,595 h.p. in the corresponding period of last year. These figures, when compared also with the total sales of engines from the formation of the company to March 31st, 1905—namely, 9,000 h.p.—showed that the company was by no means dead, even though the accounts presented did not represent it as being in a very flourishing condition. In the past they had had trouble with some of the engines first delivered, but this was due to no fault of the company, the responsibility resting with the makers. He was glad to say that trials which had since been conducted by the makers, under the guidance of this company's engineer and manager, had proved very successful. The faults had all been overcome and adjusted, and the engines were now first-class saleable articles. This was proved by the fact that they had had many repeat orders for larger engines from people who had previously been dissatisfied. At the present time experiments were going on, which they had every reason to believe would be successful, with a view to the introduction of a two-stroke engine, to cost considerably less per horse-power than the old engines. The space occupied by this new engine would be about the same as that occupied by the old one, but its power would be doubled and there would be a saving of some 25 per cent. in weight. In the past they had been handicapped somewhat by the weight of the engines, and they looked upon this two-stroke engine as being a very valuable addition, particularly for use where large space was not available. The patents for these two-stroke engines had either been obtained or applied for in Germany. The engine and dynamo exhibited at Olympia created a considerable amount of inquiry among people interested in electric lighting and traction, and had resulted in orders coming to the company; and there was hope of the seed there sown bearing further fruit. Difficulty was sometimes experienced in selling the engines in this country owing to their being made in Germany and elsewhere. The Government, for instance, naturally preferred to have English engines; indeed, they insisted upon them. The directors had therefore entered into a contract with Messrs. Willans & Robinson, of Rugby, which they considered would be a very profitable one for this company. No engines had as yet been made for the company by Messrs. Willans and Robinson, because a considerable amount of preparation was necessary. After a few references to the reduction of capital proposal which had previously been carried, the report was adopted.

The meeting was also briefly addressed by Mr. Browett, the manager, who said that when the various things spoken of by the chairman had been carried out there was no reason why the company should not enter upon a career of prosperity.

Burmah Electric Tramways and Lighting Co.

Mr. E. C. Morgan presided at the meeting held at 1, Queen Victoria Street, on 21st inst., and in moving the adoption of the report, he said that the accounts covered a full year's working to July 31st, 1905. The traffic receipts had been £13,777, received from 2,807,287 passengers, on a car-mileage of 553,494. They had spent £11,329, leaving a surplus of £2,457, or about 2½ per cent. on the preference shares. That sum was not divisible at present, however, being employed in stocks and stores in hand. Fuel figured at £2,057 in their expenses. Wood was not only a dear, but a wasteful form of fuel, and they might shortly expect to obtain good coal from fields near Mandalay, which would lead to a considerable saving. The traffic was showing a satisfactory increase. The report was adopted.

Manx Electric Railway Co.

The report for the year ended Sept. 30th, 1905, shows that the receipts were £32,638 and the gross expenditure £15,349, leaving net earnings £17,289. After deducting debenture interest £9,054, and adding balance brought forward £780, there is a credit balance of £9,015. After payment of dividend due on the preference shares there remains a balance of £2,205, which the directors propose should be carried forward. During the year a further capital expenditure has taken place of £5,995, from which the company has not yet reaped the full benefit; whilst preference shares for £6,325, and debenture stock for £2,500, have been issued. A considerable amount has again been spent out of revenue in maintenance and renewals, and the whole line is kept in good repair. The summer season in the Isle of Man has shown considerable improvement over the previous year. Visitors have been a good deal more numerous, and passengers carried during the past twelve months totalled 501,696, as compared with 472,556 carried during the previous twelve months.

New Brotherton Tube Co.—The report for the year ended August 31st, 1905, shows a loss on the year's trading of £405, and after deducting the amounts written off for depreciation of plant, &c, maintenance of buildings, &c., auditors' and directors' fees, the debit carried to profit and loss account is £2,477. From this has to be deducted the balance brought forward from last account, and it is proposed to transfer £2,000 from the reserve account to meet this deficiency, leaving a credit of £12 to profit and loss account, and £500 to reserve account.—*Financial Times.*

W. and T. Avery.—The directors have declared interim dividends at the rate of 5 per cent. per annum on both preference and ordinary shares for the half-year ended September 30th last.

MARKET QUOTATIONS.

Wednesday, December 27th.

CHEMICALS, &c.		Latest Price.	Fortnight's Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	..
a ,, Nitric	per cwt.	22/-	..
a ,, Oxalic	per cwt.	32/-	..
a ,, Sulphuric	per cwt.	5/6	..
a Ammoniac, Sal	per cwt.	42/-	..
a Ammonia, Muriate (crystal)	per ton	£33 10	..
a ,, ,,	per ton	£30	..
a Bleaching powder	per ton	£5 10	..
a Bisulphide of Carbon	per ton	£18	..
a Borax	per ton	£13	..
a Benzole (90 %)	per gal.	10½d.	½d. inc.
a ,, (50 %)	per gal.	10d.	½d. inc.
a Copper Sulphate	per ton	£23 15	25/- inc.
a Lead, Nitrate	per ton	£25	..
a ,, White Sugar	per ton	£31	..
a ,, Peroxide	per ton	£27 10	..
a Methylated Spirit	per gal.	2/6	..
a Naphtha, Solvent (90 % at 160° C)	per gal.	5/6	..
a Potassium Bichromate, in casks	per lb.	3d.	..
a Potash, Caustic (75/80 %)	per ton	£20	..
a Potassium Cyanide	per lb.	7½d.	..
a Shellac	per cwt.	190/-	..
a Sulphate of Magnesia	per ton	£4 10	..
a Sulphur, Sublimed Flowers	per ton	£6 10	..
a ,, Recovered	per ton	£5 10	..
a ,, Lump	per ton	£5	..
a Soda, Caustic (white 70 %)	per ton	£10 15	..
a ,, Crystals	per ton	£3	..
a Sodium Bichromate, casks	per lb.	2½d.	..
a ,, Cyanide	per lb.	7d.	..
METALS, &c.			
b Aluminium Ingots, in ton lots	per ton	£150	..
b ,, Wire, in ton lots	per ton	£177	..
b ,, Sheet, in ton lots	per ton	£175	..
b Babbitt's metal ingots	per ton	£43 to £140	..
c Brass (rolled metal 2" to 12") basis	per lb.	8½d.	..
c ,, Tube (brazed)	per lb.	10½d.	..
c ,, ,, (solid drawn)	per lb.	9½d.	..
c ,, Wire, basis	per lb.	8½d.	..
c Copper Tubes (brazed)	per lb.	11½d.	..
c ,, ,, (solid drawn)	per lb.	11½d.	..
g Copper Bars (best selected)	per ton	£95	..
g Copper Sheet	per ton	£95	..
g ,, Rod	per ton	£95	..
e ,, (Electrolytic) Bars	per ton	£88	..
e ,, ,, Sheets	per ton	£100	..
e ,, ,, Rod	per ton	£92 10	..
e ,, ,, H.C. Wire	per lb.	10¾d.	..
f Ebonite Rod	per lb.	3/3	..
f ,, Sheet	per lb.	3/-	..
n German Silver Wire	per lb.	1/7	..
h Gutta-percha, fine	per lb.	6/- to 7/-	..
h India-rubber, Para fine	per lb.	5/2 to 5/8	..
i Iron, Charcoal Sheets	per ton	£18	..
i ,, Pig (Cleveland warrants)	per ton	53/9	6d. inc.
i ,, Forgings, according to size	per ton	From £11	..
i ,, Scrap, heavy	per ton	47/6 to 50/-	..
i ,, Wire, galvanised No. 8	per ton	£9 15	..
g Lead, English Ingot	per ton	£17 15 to £17 17 6	5/- inc.
g ,, ,, Sheet	per ton	£20 2 6	5/- inc.
m Manganin Wire No. 28	per lb.	8/-	..
g Mercury	per bot.	£7 5	..
d Mica (in original cases) small	per lb.	6d. to 1/-	..
d ,, ,, medium	per lb.	2/6 to 4/-	..
d ,, ,, large	per lb.	4/6 to 8/6	..
p Phosphor Bronze, plain castings	per lb.	1/1 to 1/8	..
p ,, rolled bars & rods	per lb.	1/1½ to 1/8	..
p ,, ,, strip & sheet	per lb.	1/4	..
o Platinum	per oz.	85/6	..
e Silicium Bronze Wire	per lb.	11d. to 11½d.	..
i Steel, Magnet, acc'd'g to desc'p'n	per ton	£58	..
i ,, ,, in bars		£15 to £40	..
g Tin, Block	per ton	£164 to £165	30/- dec.
n ,, Wire, Nos, 1 to 16	per lb.	1/10½	..
p White Anti-friction Metals—			
"White Ant" brand	per ton	£46 to £70	..
j Yarns, 2/10s Grey Cotton, on sp'ls	per lb.	8d.	..
j ,, 6 lea. Flax	per lb.	5½d.	..
j ,, 3 ply 10 lbs. Russian	per lb.	4½d.	..
j ,, 10 lbs. Russian, single	per lb.	4½d.	..
j ,, 180 lbs. Jute rove	per ton	£11	..
k Zinc, Sh't (Vieille Montagne bnd.)	per ton	£31 15	..

Quotations supplied by:—

a G. Boor & Co.
b The British Aluminium Co., Ltd.
c Thos. Bolton & Sons, Ltd.
d F. Wiggins & Sons.
e Frederick Smith & Co.
f India-Rubber, G.P. and Teleg. Works Co., Ltd.
g James & Shakspeare.
h Edward Till & Co.
i Bolling & Lowe.
j Walter H. Hindley & Co., Ltd.
k Morris Ashby, Ltd.
m W. T. Glover & Co., Ltd.
n P. Ormiston & Sons.
o Johnson, Matthey & Co., Ltd.
p The Phosphor Bronze Co., Ltd.

Middlesex Tramways.—At the County Council meeting on Dec. 21st, it was reported that a deadlock had ensued as a result of a conference which had taken place between representatives of the County Councils of Middlesex and Surrey and Sir Clifton Robinson in regard to the terms upon which consent would be given to the Tramways Co. constructing a line over King Edward VII. Bridge. Sir Clifton intimated that the company could not accede to the terms, chiefly because the amount of wayleave rent was too high. Both Councils' representatives stated they could not recommend any alteration in the terms. The report was adopted.

STOCKS AND SHARES.

Wednesday evening.

Reviewing in customary brief fashion the course of quotations throughout the current year, the outstanding features are the rises in Telegraph and the falls in Electric Supply issues. The reason for the latter is too recent to need repetition; had it not been for the threatened competition of the L.C.C. and one or two powerful groups proceeding much on the same lines, the following set of prices might have told a much pleasanter story. Prices for the past twelvemonth are preceded by those that ruled at the end of December, 1903:—

Share.	Dec. 31, 1903.	Dec. 31, 1904.	Now.	Change this year.
Brompton & Kensington	10½	10⅜	9	−1⅜
Charing Cross	9	8⅛	6¼	−2⅛
City of London	10⅜	11	11⅛	+ ⅛
County of London	8	9⅛	9	− ⅛
Edmundson's	6¼	6¼	5⅝	− ⅝
Kens. and Knightsbridge	11	12⅝	11¼	−1⅜
Metropolitan	17⅛	17⅛	10	—
Notting Hill	13	14⅜	14⅛	− ⅛
St. James's	15	14	13⅛	− ⅞
Urban	5	5	4⅝	− ⅜
Westminster	12½	13	12	−1

In the case of the Metropolitan Co. allowance must, of course, be made for the return of capital. No new undertaking of great importance in the London electric supply world has appeared in 1905, but new issues made by the existing concerns were generally well received.

Our Railway list is noticeable for the rise in Waterloo and City stock, and the drop in Metropolitan Consolidated. So great hopes have been built on the electrification of the two old Underground Railways that it is a matter of apparent surprise for the prices to exhibit losses. Here are the figures:—

Stock.	Dec. 31, 1903.	Dec. 31, 1904.	Now.	Change this year.
Central London Ordinary	94½	91	94	+ 3
,, ,, Preference	1 0⅛	102	102	—
,, ,, Deferred	94½	85	86½	+ 1½
City and South London	48⅛	46¼	45	− 1¼
Waterloo and City	92½	89	95½	+ 6½
Metropolitan Consolidated	86	98	87	− 11
,, District	34	40	35½	− 4½

British Electric Traction Ordinary are 8, or £2 lower as the result of the year's working. London United Tramways Preference were 10⅜ and now are 10, British Columbia Railway Deferred rose 21½ in 1904, and have added nearly 20 points more during 1905; their present value is 120½. A sharp rise took Anglo-Argentine Trams to almost 9, and the set back to 7⅞ leaves the price 2s. 6d. better on the present year.

Pronounced strength is shown by most of the Telegraph descriptions. The chief honours are shared by Eastern Telegraph stock, Great Northern and Indo-European shares, as may be now seen:—

Stock or share.	Dec. 31, 1903.	Dec. 31, 1904.	Now.	Change this year.
Anglo Preferred	93	104½	109½	+ 5
,, Deferred	8	13⅛	17⅛	+ 3⅞
Cuba Submarine	7⅛	9	8⅞	− ⅛
Direct U.S.	10⅛	10⅞	14½	+ 3⅝
Eastern Extension	11⅛	13⅜	14⅜	+ 1
Eastern Telegraph	123⅝	136½	145½	+ 9
Great Northern	25⅜	29	37½	+ 8½
Indo-European	38½	45½	58	+12½
Western Telegraph	12	13½	14	+ ½
National Telephone Pref.	102	109	111	+ 2
,, ,, Def.	78½	103	109	+ 6

War in the Extreme East proved a good thing for the cable companies, and a long period of activity in American Railroad shares is reflected in the rise of Anglo-American stocks and Direct United States shares. National Telephones advanced with the prosperous progress of the company.

With the general revival in trade, manufacturing shares have mostly sympathised, as may be seen by a few representative examples:—

Share.	Dec. 31, 1903.	Dec. 31, 1904.	Now.	Change this year.
British Insulated	6½	5½	6⅝	+1⅛
Brit. Westinghouse Pref.	4¾	2⅜	2	− ⅜
Callender's	11½	9⅞	11⅛	+1⅛
Electric Construction	1⅝	1⅛	⅜	− ¾
Edison & Swan	⅜	⅜	1⅝	+ 1⅛
Henley's	14	10½	13	+2½
India-Rubber	18½	15⅝	19	+3⅜
Telegraph Construction	35½	39	33	−6

Edison & Swan have improved considerably, and last year's fall in Callenders has been quite recovered. Henley's has also had a substantial advance, and the outlook for these companies is certainly good. Were conditions brighter in the Electric Supply section, the departments under the electrical heading would be ending the year in a very satisfactory state. But perhaps the elements of uncertainty now surrounding the outlook for these companies will disperse, as quickly as we trust they may, in a happy and prosperous New Year.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last four years. 1902.	1903.	1904.	1905. §	Closing Quotations Dec. 20th.	Closing Quotations Dec. 27th.	Business done week ended Dec. 27th, 1905. Highest	Lowest.	Rise + or Fall —
84,800	African Direct Telegraph, 4 % Debs...	100	4 %	4 %	4 %	4 %	99 —102	99—102	..	..	..
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	Nil	Nil	Nil	..	85 — 90	85 — 90	..	..	..
119,700£	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	Nil	Nil	Nil	5 %	..	..	..	..	..
768,580	Anglo-American Telegraph	Stock	60/6	61s.	29/6	29s. §	61 — 63	62 — 64	..	..	+1
3,118,210	Do. do. do. 6 % Pref.	Stock	6 %	6 %	6%	6s. §	109 —110	109 —110	109⅔	..	..
3,118,210	Do. do. do. Deferred	Stock	1/-	2s.	Nil	..	16⅞ — 17	17⅛ — 17⅜	17 1/16	17 1/16	+ ⅛
50,000	Anglo-Portuguese Tel., 5% Mort. Deb. Stock Red.	100	..	..	..	..	102 —104	102 —104	..	..	..
44,000	Chili Telephone, Nos. 1 to 44,000	5	6 %	7 %	8 %	..	7⅞ — 8	7⅞ — 8	..	..	..
1,932,856£	Commercial Cable Stng. 500 year 4 % Deb. Sk. Red.	Stock	4 %	4 %	4 %	4 %	96⅞ — 98⅛	96⅞ — 98⅛	97⅛	..	..
16,000	Cuba Telegraph	10	6⅔ %	10 %	5 %	5 %§	8¾ — 9	8¾ — 9	..	..	..
6,000	Do. 10 % Pref.	10	10 %	5 %	10 %	10 %§	17 — 18	17 — 18	..	..	..
12,931	Direct Spanish Telegraph, Ord.	5	4 %	4 %	4 %	4 %§	3⅞ — 3⅝	3⅞ — 3⅝	..	..	..
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 %§	8¾ — 9¼	8¾ — 9¼	..	..	..
80,000	Do. do. 4½ % Debs.	50	4½%	4½%	4½%	4½%§	100 —103 %	100 —103	..	..	..
60,710£	Direct United States Cable	20	3⅛%	3%	3⅛%	3 %§	14 — 15	14 — 15	14½	..	..
74,500	Direct W. India Cable, 4½ % Reg. Deb., 1 to 1,200, R.	100	4½%	4½%	4½%	4½%	101 —103	101 —103	..	..	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	5 %§	144 —147	144 —147	146⅔	145½	..
2,000,000	Do. 8½ % Pref. Stock	100	8½%	8½%	8½%	8½%§	90 — 92	90 — 92	91½	..	..
1,836,814	Do. 4 % Mort. Deb. Stock Red. ..	Stock	4 %	4 %	4 %	4 %§	106 —108	106 —108	..	..	..
300,000	Eastern Extension, Australiasia, and China Tele.	10	7 %	7 %	7 %	6 %§	14½ — 15	14½ — 15	14⅝	..	..
602,400	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	4 %§	106 —108	106 —108	106⅞	..	..
800,000	East & S. Afric. Tel., 4 % Mt. Db., 1 to 8,000, red. 1909	100	4 %	4 %	4 %	4 %	100 —102	100 —102	..	..	..
200,000£	Do. 4 % Reg. M. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	4 %	100 —102	100 —102	..	..	..
180,887	Globe Telegraph and Trust	10	£3	5½%	5⅝%	5 %	10⅜ — 10⅝	10⅜ — 10⅝	10⅞	10⅛	..
180,887	Do. do. 6 % Pref.	10	6 %	6 %	6 %	6 %	14⅜ — 14⅝	14⅜ — 14⅝	..	..	..
150,000	Great Northern Telegraph, of Copenhagen .	10	12½%	15 %	24 %	..	37 — 39	36⅛ — 38⅛	36	..	— ⅛
46,500	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	4½%	4½%	4½%	4½%	101 —103	101 —103	..	..	..
17,000	Indo-European Telegraph	25	10 %	10 %	13 %	5 %	57 — 59	57 — 59	57	..	..
251,127	Marconi's Wireless Telegraph	1	..	..	..	..	1⅛ — 1⅜	1⅛ — 1⅜	..	..	..
72,680	Monte Video Telephone Co., Ltd. Ord.	1	3 %	3 %	4 %	..	⅞ — 1	⅞ — 1	..	..	..
66,422	Do. do. do. 5 % Pref. ..	1	5 %	5 %	5 %	..	⅞ — 1	⅞ — 1	..	..	..
1,983,33£	National Telephone, Pref. Stock	100	6 %	6 %	6 %	6 %§	110⅛—111⅛	110⅛—111⅛	111⅛	110½	..
1,966,66£	Do. do. Def. Stock	100	4½%	5 %	5 %	5 %§	108 —110	108 —110	108½	..	..
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	6 %§	13 — 15	13 — 15	..	..	..
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	6 %§	11 — 13	11 — 13	12⅛	..	..
250,000	Do. do. 5 % Non-cum. 3rd P., 1 to 250,000	5	5 %	5 %	5 %	5 %§	5⅝ — 5¾	5⅝ — 5¾	..	..	..
2,000,000	Do. do. 3½ % Deb. Stock Red. ..	Stock	3½%	3½%	3½%	3½%	98½—100¼	98⅛—100¼	99	98½	..
1,689,593	Do. do. 4 % Deb. Stock Red. ..	100	4 %	4 %	4 %	4 %	104 —106	104 —106	..	..	..
179,313	Oriental Telep. and Elec. 1 to 171,504, fully paid	1	6 %	6¾%	6¾%	6 %	1⅛ — 1⅜	1⅛ — 1⅜	..	..	..
50,000	Do. do. do. 6 % Cum. Pref. ..	1	6 %	6 %	6 %	6 %	1⅛ — 1⅜	1⅛ — 1⅜	..	..	..
100,000	Pacific & European Tel., 4 % Guar. Debs., 1 to 1,000	100	4 %	4 %	4 %	4 %	100 —103	97 — 99	..	..	—3½
11,889£	Reuter's	8	5 %	5 %	5 %	5 %§	7⅞ — 7¾	7⅞ — 7¾	..	..	..
60,000	Telephone Co. of Egypt, 4½ % Deb. Red. ..	100	..	..	..	4½%	103 —106	103 —106	..	..	..
3,257	Submarine Cables Trust	Cert.	6 %	6 %	6 %	6 %	125 —128	125—128	..	..	..
58,000	United River Plate Telephone	5	7 %	8 %	8 %	..	7⅛ — 8	7⅛ — 8	..	..	..
40,000	Do. 5 % Cum. Pref., Nos. 1 to 40,000	5	5 %	5 %	5 %	5 %	5⅛ — 5⅜	5⅛ — 5⅜	..	..	..
179,947	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	5 %	111 —113	111 —113	..	..	..
15,609£	West African Telegraph, Shares	10	2 %	4 %	4½%	4 %	9⅛ — 10	9⅛ — 10	..	..	..
30,008	W. Coast of America, 1 to 30,000 & 53,001 to 53,008	2½	Nil	Nil	Nil	..	1/16 — 1/8	1/16 — 1/8	..	..	..
150,000	Do. 4 % Debs., 1 to 1,500 guar. by Braz. Sub. Tel.	100	4 %	4 %	4 %	4 %	100¼—102⅛	100⅛—102⅛	..	..	..
207,980	Western Telegraph, Ltd., Nos. 1 to 207,980 ..	10	7 %	7 %	7 %	5 %	13⅞ — 14⅛ xd	14 — 14⅛	..	..	+ ⅛
75,000	Do. do. 5 % Debs. 2nd series, 1906	100	5 %	5 %	5 %	5 %	102 —104	103 —104	..	..	..
563,380	Do. do. 4 % Deb. Stock Red. ..	100	4 %	4 %	4 %	4 %	103¼—105½	103¼—105½	105	..	..
88,321	West India and Panama Telegraph	10	Nil	Nil	Nil	..	2 — 3	2 — 3	..	..	..
84,763	Do. do. 6 % Cum. 1st Pref.	10	7 %	7 %	6 %	6 %	8⅞ — 8¾	8⅞ — 8¾	8¾	8¼	..
4,639	Do. do. 6 % Cum. 2nd Pref.	10	Nil	Nil	Nil	..	6¾ — 7¼	6¾ — 7¼	..	..	..
80,000£	Do. do. 5 % Debs., Nos. 1 to 1,800 ..	100	5 %	5 %	5 %	5 %	101 —104	101 —104	..	..	..

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

850,000	Anglo-Argentine Trams, 260,008 to 430,007	5	..	..	8 %	6 %§	8⅝— 8⅞	8⅝— 8⅞	8⅞	..	..
1,300,035	Do. 5½ % Cum. Prefs., 1 to 260,007 ..	5	..	5 %	5 %	5½%	5⅞ — 6⅛	5⅞ — 6⅛	..	..	..
265,600	Do. Permanent, 6 % Deb. Stock, 1888	100	..	6 %	6 %	6 %	142 —145	142 —145	..	..	..
260,000	Auckland E. Trams., 5 % 1st Mort. Deb. Stock ..	100	..	5 %	5 %	5 %	105 —107	105 —107	..	..	..
530,000	Babcock & Wilcox, 1 to 530,000	1	..	17 %	20 %	16 %‖	3⅜ — 4	3⅜ — 4	3⅝	3⅜	..
100,000	Do. do. 6 % Cum. Pref., 1 to 100,000 ..	1	..	6 %	6 %	6 %	1 1/16 — 1 1/8	1 1/16 — 1 1/8	1⅛	..	..
40,000	British Aluminium 7 % Cum. Pref.	5	Nil	Nil	Nil	3/6	5 — 5¼	5¼ — 5⅜	5⅜	..	+ ⅛
30,000	Do. do. "A" 6 % Cum. Pref.	5	Nil	Nil	Nil	3/-	4⅜ — 5⅛	4⅜ — 5⅛	..	..	..
20,000	Do. do. 4 % Funding Certs.	5	..	..	..	..	2¾ — 3¼	2¾ — 3¼	..	..	..
300,000£	Do. do. 5 % 1st Mort. Deb. Stock Red.	Stock	5 %	5 %	5 %	5 %	98 —102	98 —102	..	..	..
300,000	British Columbia E. Rail Def. Ord. Stock	100	..	6 %	6 %	..	119 —122	119 —122	..	..	..
300,000	Do. 5 % Pref. Ord. Stock	100	..	5 %	5 %	..	109 —113	107 —111	..	..	—2
115,000	Do. 6 % Cum. Perp. Pref. Stock	100	..	5 %	5 %	5 %	106 —109	106 —109	..	..	..
240,000	Do. 4½ % 1st Mort. Debs., 1 to 6,250	40	..	4½%	4½%	4½%	103 —105 %	103 —105%	..	..	..
200,000	Do. 4½ % Vancouver Power Debs., 1 to 2,200	100	..	4½%	4½%	4½%	102 —105	102 —105	..	..	..
133,331	British Electric Traction	10	8 %	6 %	6 %	..	7⅛ — 8¼	7⅛ — 8¼	8¼	8 1/16	..
156,497	Do. do. 6 % Cum. Pref.	10	6 %	6 %	6 %	..	10 — 11	10 — 11	10½	10 1/16	..
1,000,000£	Do. do. 5 % Perp. Deb. Stock ..	Stock	5 %	5 %	5 %	5 %	117 —119	117 —119	118	..	..
250,000	Do. do. 4½ % 2nd Deb. Stock Red.	100	..	..	4½%	4½%	97 — 99	97 — 99	..	..	..
100,000	British Insulated and Helsby Cables	5	10 %	8 %	8 %	8 %§	6¾ — 7	6¾ — 7	..	..	..
100,000	Do. do. 6 % Cum. Pref.	5	6 %	6 %	6 %	6 %§	5⅞ — 6⅛	5⅞ — 6⅛	..	..	..
500,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	4½%	4½%	4½%	4½%§	103 —106	103 —106	..	..	..
212,000	British Thomson-Houston 4½ % 1st Mort. Debs. ..	100	..	4½%	4½%	4½%	98 —100	98 —100	..	..	..
2,000,000	British Westinghouse 6 % Pref., 1 to 200,000 and 275,001 to 475,000	5	..	6 %	Nil	..	1⅞ — 2¼	1⅞ — 2¼	..	..	..
1,016,353	Do. do. 4 % Mort. Deb. Stock ..	100	..	..	4 %	4 %	80 — 85	80 — 85	80	..	..
50,000	¶Browett, Lindley & Co., Ord.	£1	Nil	Nil	Nil	..	9/16 — 11/16	9/16 — 11/16	..	..	..
50,000	¶ Do. do. 6 % Cum. Pref.	£1	Nil	Nil	Nil	..	14/6 to 15/6	14/6 to 15/6	..	..	..
105,731	Brush Electrical Engineering, Ord., 1 to 105,731 ..	1	Nil	Nil	Nil	..	1/2 — 5/8	1/2 — 5/8	..	..	..
150,000	Do. Non-cum. 6 % Pref.	2	6 %	6 %	6 %	..	1⅛ — 1⅜	1⅛ — 1⅜	..	..	..
125,000£	Do. 4½ % Perp. Deb. Stock ..	Stock	4½%	4½%	4½%	4½%	96 —100	96 —100	..	..	..
125,000£	Do. 4½ % Perp. 2nd Deb. Stock	Stock	4½%	4½%	4½%	4½%	84 — 86	84 — 86	..	..	..
500,000	Buenos Ayres & Belgrano, 1 to 100,000	5	..	3 %	4 %	..	3⅜ — 3⅝	3⅜ — 3⅝	3½	3⅜	..
200,000	Do. "A" 6 % Cum. Pref., 1 to 40,000	5	..	6 %	6 %	..	5 1/16 — 5 1/8	5 1/16 — 5 1/8	..	..	..
187,500	Do. "B" 1 to 27,500	5	..	6 %	6 %	..	5 — 5⅛	5 — 5⅛	..	..	..
317,700	Do. 5 % Deb. Stock	100	..	5 %	5 %	5 %	107 —109	107 —109	109	..	..
190,000	Do. 5 % 2nd Deb. Stock	100	..	5 %	5 %	5 %	102 —105	102 —105	104½	..	..
525,000	Calcutta Trams., 1 to 105,000	5	..	6 %	8 %	7 %§	9¼ — 9⅜	9¼ — 9⅜	..	..	..
163,950	Do. 105,001to 137,610	5	..	..	..	3d.	8¾ — 9	8¾ — 9	..	..	..
350,000	Do. 4½ % 1st Deb. Stock	100	..	4½%	4 %	4½%	107 —109	107 —109	..	..	..
35,000	Callendar's Cable Construction shares	5	15 %	12½%	12½%	10%	11 — 12	11 — 12	..	..	..
40,000	Do. do. 5 % Cum. Pref.	5	5 %	5 %	5 %	5 %	5⅝— 5¾	5⅝— 5¾	..	..	..
300,000	Do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	4½%	4½%	4½%	4½%	109 —111	109 —111	..	..	..
491,222	Cape E. Trams., 1 to 491,222	1	..	15 %	10 %	5 %§	1⅞ — 1⅞	1⅞ — 1⅞	..	..	..
450,000	Castner-Kellner Alkali, 1 to 450,000	1	..	4 %	4 %	..	1 — 1⅛	1 — 1⅛	..	..	..
230,211	Do. do. 4½ % 1st Mort. Deb. Stock	100	..	4½%	4½%	4½%	97 —102	97 —102	99⅞	99½	..
1,968,208	Central London Railway, Ord. Stock	Stock	4 %	4 %	4 %	4 %§	93 — 95	93 — 95	93⅞	93⅝	..
523,396	Do. do. 4 % Pref. Stock	Stock	4 %	4 %	4 %	4 %§	101 —103	101 —103	..	..	..
523,396	Do. do. Def. do.	Stock	4 %	4 %	4 %	..	85 — 88	85 — 88	86⅜	..	..
1,980,000	City and South London Railway	Stock	3½%	2⅞%	2½%	2 %§	44 — 46	44 — 46	44⅜	..	..
85,000	Crompton & Co., Nos. 1 to 85,000	8	5 %	2½%	2½%	..	2 — 2¼	2 1/16 — 2 1/8	2 3/32	..	+ 1/16
100,000£	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 Red.	..	5 %	5 %	5 %	5 %	97 —100%	97 —100%	94	..	..

* A period of nine months. † Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. § Interim dividends.
‖ And bonus of 10s. ¶ From Manchester Share List.

(Continued on next page.)

SHARE LIST OF ELECTRICAL COMPANIES.—*(Continued).*

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.—*(continued).*

Present Issue.	NAME.	Stock or Share.	Dividends for the last four years. 1902.	1903.	1904.	‡1905.	Closing Quotations Dec. 20th.	Closing Quotations Dec. 27th.	Business done week ended Dec. 27th, 1905. Highest.	Lowest.	Rise + or Fall−
260,000	Dick, Kerr & Co., 1 to 52,000	† 5	..	..	10 %	..	8¼ — 9	8¼ — 9	..	..	..
305,000	Do. do. 6 % Cum. Pref., 1 to 61,000	5	..	6 %	6 %	6 %	5½ — 6¼	5½ — 6¼	..	..	..
294,150	Do. do. 4½ % Deb. Stock	100	..	4½ %	4½ %	4½ %	106 —108	106 —108	..	..	..
600,000	Dublin United Trams. (1896), 1 to 60,000	10	..	5% %	6 %	3 %	13½ — 14½	13½ — 14½	..	..	..
599,700	Do. 6 % Pref. between 1 and 60,000	10	..	6 %	6 %	6 %	14½ — 15½	14½ — 15½	..	..	..
63,400	Do. 4 % Debs.	100	..	4 %	4 %	4 %	99½ —100½	99½ —100½	..	..	..
300,000	Do. 3½ % "A" Debs.	100	..	3½ %	3½ %	3½ %	98 — 99	98 — 99	..	..	..
300,000	Do. 3½ % "B" Deb. Stock	100	..	3½ %	3½ %	3½ %	96 — 97	96 — 97	..	..	..
99,261	Edison & Swan Utd., "A" shrs., £8 pd., 1 to 99,261	5	Nil	Nil	2½ %	..	1⅛ — 1⅜	1⅛ — 1⅜	..	..	..
17,139	Do. "A" shares, 01—017,139	5	Nil	Nil	2½ %	..	2 — 2⅛	2⅛ — 2⅜	..	..	+ ⅛
844,028‖	Do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	4 %	85 — 90	85 — 90	..	..	..
100,000‖	Do. 5 % 2nd Deb. Stock Prov. Certs. all pd.	100	5 %	5 %	5 %	5 %	92 — 97	92 — 97	..	..	..
112,100	Electric Construction 1 to 112,100	2	6 %	4 %	Nil	..	⅛ — ⅜	⅛ — ⅜	..	..	..
31,890	Do. do. 7 % Cum. Pref., 1 to 31,890	2	7 %	7 %	7 %	..	1⅞ — 2⅛	1⅞ — 2⅛	..	..	..
200,000	Do. do. 4 % Perp. 1st Mort. Deb. Stk.	Stock	4 %	4 %	4 %	4 %	92 — 95	92 — 95	..	..	..
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	5 %	5 %	5 %	..	9¼ — 9⅜	9¼ — 9⅜	..	..	..
200,000	Do. do. 4 % Mort. Deb.	Stock	4 %	4 %	4 %	4 %	96 —100	96 —100	..	..	..
780,000	Gt. N. & City Rail Pref. Ord. "A" 4 % 1 to 78,000	10	..	3 %	4 %	4 %	5 — 5⅛	5 — 5⅛	..	..	..
96,000	Greenwood & Batley 7 % Cum. Pref.	10	..	7 %	7 %	7 %	10½ — 11½	10½ — 11½	..	..	..
80,000	Do. do. 5 % Mort. Debs.	100	..	5 %	5 %	5 %	102 —104	102 —104	..	..	..
200,000	Henley's (W. T.), Telegraph Works, Ord.	5	20 %	15 %	15 %	10% %	12⅛ — 13⅛	12⅛ — 13⅛	13⅛	13	..
200,000	Do. do. 4½ % Pref.	5	4½ %	4½ %	4½ %	4½ %	5⅛ — 5⅜	5⅛ — 5⅜	..	..	..
45,900	Do. do. 4½ Mort. Deb. Stock	Stock	4½ %	4½ %	4½ %	4½ %	.. — ..	.. — ..	..	..	..
50,000	India-Rubber, Gutta-Percha & Telegraph Works.	10	10 %	10 %	5 %	2½%	18½ — 19½	18½ — 19½	19½	..	..
800,000‖	Do. do. 4% 1st Mort. Deb.	100	4 %	4 %	4 %	4 %	99 —102	99 —102	..	..	..
37,500	†Liverpool Overhead Railway, Ord.	10	1½%	1½%	1½%	..	1⅞ — 2⅛	1⅞ — 2⅛	..	..	— ⅛
10,000	† Do. do. Pref. £10 paid	10	5 %	5 %	5 %	5 %	6¾ — 7	6½ — 6⅝	..	..	— ¼
600,070	London United Trams (1901), 1 to 50,007	10	..	8 %	6 %	4 %‖	10 — 11	9 — 11	..	..	..
399,930	Do. do. 60,008 to 100,000 (£4 paid)	10	..	8 %	6 %	4 %‖	4 — 5	4 — 5	..	..	..
1,125,000	Do. do. 5 % Cum. Pref., 1 to 125,000	10	..	5 %	5 %	5 %	9⅜ — 10⅛	9⅜ — 10⅛	10⅛	..	..
1,331,000	Do. do. 4 % 1st Mort. Deb. Stock	100	..	4 %	4 %	4 %	100 — 103	100 —103	101⅛	100⅛	..
314,016	Metropolitan Electric Trams, Defd.	1	Nil	Nil	Nil	..	31/32 — 1	31/32 — 1	..	..	..
500,000	Do. 5 % Cum. Pref.	1	5 %	5 %	5 %	5 %	1— 1⅛	1— 1⅛	..	..	..
350,000	Do. 4½ % Deb. Stock Red.	100	..	..	4½ %	4½ %	106—108	106 —108	..	..	..
160,000	Peebles (B.) & Co. 6 % Cum. Pref., 20,001 to 40,000	5	..	..	6 %	6 %	4⅞ — 5⅛	5 — 5⅛	..	..	+ ⅛
240,500	Potteries E. Trc., 20,001 to 40,000 & 50,001 to 54,500	10	..	5 %	5 %	..	8¾ — 9⅛	8¾ — 9⅛	..	..	..
240,500	Do. 5 % Cum. Pref., 1 to 20,000 & 40,001 to 44,500	10	..	5 %	5 %	5 %	9¾ — 10⅛	9¾ — 10⅛	..	..	..
245,000	Do. 4½ % Deb. Stock	100	..	4½ %	4½ %	4½ %	103 — 106	103 —106	..	..	..
37,350	Telegraph Construction and Maintenance	12	20 %	20 %	15 %	10 %	3⅛ — 3¼	32 — 34	33⅛	33¼	..
150,000‖	Do. 4 % Deb. Bds., 1 to 1,500 Red. 1909	100	4 %	4 %	4 %	4 %	102 —104	102 —104	..	..	+ ½
3,599,200	Undergd. E. R., Lon., 5 % Profit Shar. S. Nts.	..	..	..	5 %	5 %	96 — 98	97 — 98 xd	..	..	..
640,000	Waterloo & City Railway, Ord. Stock	100	3¼%	3¼%	9½ %	3 %‖	94 — 97	94 — 97	94	..	..
333,330	Willans & Robinson, 1 to 80,000 & 80,001 to 116,666	5	6¾%	6 %‖	..	..	1¾ — 2⅛	1¾ — 2⅛	..	..	..
333,330	Do. 6 % C. P., 80,001 to 80,000 & 125,001 to 141,666	5	..	6 %	..	..	3 — 3⅜	3¼ — 3⅜	..	..	+ ⅛
246,806	Do. 4 % 1st Mort. Deb. Stock	100	..	4 %	4 %	4 %	82 — 87	82 — 87	..	..	..

ELECTRICITY SUPPLY COMPANIES.

70,000	Bromley (Kent) E.L. & P., 1 to 14,000	5	..	5 %	5¼%	4 %‖	5⅛ — 5⅜	5⅛ — 5⅜	..	..	..
50,000	Do. do. 4½ % 1st. deb. stock	100	..	4½ %	4½ %	4½ %	102 —105	102 —105	..	..	..
29,377	Brompton & Kens. Elec. Lt. Sup., Ord., 1 to 20,000	5	8 %	10 %	10 %	9 %	8⅞ — 9⅛	8⅞ — 9⅛	..	..	..
29,623	Do. do. 7 % Cum. Pref.	5	7 %	7 %	7 %	7 %	9 — 9⅛	9 — 9⅛	..	..	..
10,782	Central Electric Supply 4 % Guar. Deb. Stock	100	4 %	4 %	4 %	4 %	102 —105	102 —105	..	..	..
80,000	Charing Cross and Strand Electricity Supply	5	10 %	8 %	8 %	5 %‖	5⅜ — 6⅜	5⅜ — 6⅜	..	..	..
80,000	Do. do. do. 4½ % Cum. Pref.	5	4½ %	4½ %	4½ %	4½ %	5⅛ — 5½	5⅛ — 5½	5⅛	..	..
40,000	Do. "City Undertaking" 4½ % Cum. Prf.	5	4½ %	4½ %	4½ %	4½ %	4¾ — 5	4¾ — 5	4⅞	..	..
40,000	Do. do. 1903	5	4½ %	4½ %	4½ %	4½ %	4¾ — 5	4¾ — 5	4⅞	..	..
350,000	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	4 %	101 —103 xd	101 —103 xd	..	..	..
44,436	Chelsea Electricity Supply, Ord.	5	4½ %	5¼%	6 %	4½%‖	5 — 6	5 — 6	..	..	..
150,000‖	Do. do. 4½ % Deb. Stock Red.	Stock	4½ %	4½ %	4½ %	4½%‖	110 —112	110 —112	..	..	..
70,595	City of London Elec. Lighting, Ord. 40,001—110,595	10	5 %	5 %	6 %	5 %	11 — 12	11 — 12	11½	..	..
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	6 %	13½ — 14½	13½ — 14½	..	..	..
400,000‖	Do. 5 % Db. Stk., Scrip. (iss. at 115) all pd.	..	5 %	5 %	5 %	5 %	124 —128	124 —128	..	..	..
800,000	Do. 4½ % 2nd Db. Stk., Prov. Crts., all pd.	100	4½ %	4½ %	4½ %	4½ %	103 —105	103 —105	..	..	..
40,000	County of Durham Electrical Power, Ord.	2	..	..	..	..	2⅛ — 2⅜	2⅛ — 2⅜	..	..	..
50,000	Do. do. 5 % Pref.	5	..	..	..	..	5⅛ — 5⅜	5⅛ — 5⅜	..	..	..
40,000	County of London Electric Lighting, Ord. 1—40,000	10	4 %	4 %	4½ %	4 %‖	8¾ — 9⅛	8¾ — 9⅛	8⅞	8⅞	..
30,000	Do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	6 %	12¾ — 12⅞	12¾ — 12⅞	12⅞	..	..
400,000‖	Do. do. 4½ % Deb. Stock	..	4½ %	4½ %	4½ %	4½ %	112 —115	112 —115	114⅝	..	..
250,000	Do. do. 4½ % 2nd Deb. Stock	Stock	4½ %	4½ %	4½ %	4½ %	101 —103	101 —103	..	..	..
70,000	Edmundson's Electric Corporation, Ord. Shares	5	7 %	7 %	7 %	..	5⅛ — 5⅜	5⅛ — 5⅜	..	..	..
60,000	Do. do. 6 % Cum. Pref.	5	6 %	6 %	6 %	6 %	5⅝ — 6	5⅝ — 6	..	..	..
200,000‖	Do. do. 4½ % 1st Mort Deb. Stk	100	4½ %	4½ %	4½ %	4½ %	107 —109	107 —109	..	..	..
50,000	Folkestone, 1 to 10,000	5	..	5% %	5% %	4 %‖	5⅛ — 5⅜	5⅛ — 5⅜	..	..	..
50,000	Do. 5 % Cum. Pref., 1 to 10,000	5	..	..	..	5 %	5 — 5⅛	5 — 5⅛	..	..	..
50,000	Do. 4½ % 1st. Deb. Stock	100	..	4½ %	4½ %	4½ %	101 —104	101 —104	..	..	..
65,000	Hove, 1 to 13,000	5	..	8½%	8½%	8 %	8⅛ — 8⅜	8⅛ — 8⅜	..	..	..
10,000	Do. New (£5 10s. paid)	£3	..	8½%	8½%	8 %	5¾ — 6¼	6 — 7	..	..	+ ⅛
37,300	Do. 4 % Deb. Stock	100	..	4 %	4 %	4 %	94 — 97	94 — 97	..	..	..
7,300	Do. 4½ % Deb. Stock	100	..	4½ %	4½ %	4½ %	98 —100	98 —100	..	..	..
21,000	Kensington and Knightsbridge Electric Ord.	5	10 %	12½%	12 %	10 %‖	10⅜ — 11⅜	10⅜ — 11⅜	..	..	..
136,000	Do. do. do. 4 % Deben. Stk.	Stock	4 %	4 %	4 %	4 %	96 —101	98 —101	..	..	+1
111,000	London Electric Supply Corporation, Limited, Ord.	3	Nil	Nil	3 %	..	1⅜ — 2⅛	1⅜ — 2⅛	..	..	..
60,000	Do. do. do. 6 % Pref.	5	6 %	6 %	6 %	6 %	4⅜ — 5⅛	4⅜ — 5⅛	..	..	..
371,895	Do. do. 4 % 1st Mort. Deb. Stk. Red.	Stock	4 %	4 %	4 %	4 %	97 —100 xd	97 —100 xd	..	..	..
100,000	Metropolitan Electric Supply, 1 to 100,000	5	7½%	8½%	10 %	10 %‖	9 — 10	9⅛ — 10⅛	9⅛	9⅛	+ ⅛
76,121	Do. 4½ % Cum. Pref. 1—71,106, £3 pd.	5	4½ %	4½ %	4½ %	4½ %	5⅛ — 5⅜	5⅛ — 5⅜	..	..	..
220,000‖	Do. 4½ % 1st Mort. Deben. Stock	..	4½ %	4½ %	4½ %	4½ %	109 —113	109 —113	..	..	..
250,000‖	Do. 3½ % Mort. Deben. Stock Redem.	Stock	3½ %	3½ %	3½ %	3½ %	97 — 99	97 — 99	..	..	..
250,000	Midland Electric Corporation, 4½ % 1st Mort. Deb.	100	4½ %	4½ %	4½ %	4½ %	101 —103 %	101 —103%	101⅜	..	..
285,045	Newcastle-on-Tyne, 1 to 57,009	5	..	8 %	8 %	2½%‖	8 — 8¼	8 — 8¼	..	..	..
89,955	Do. 57,010 to 75,000	5	..	..	..	2½‖	8 — 8¼	8 — 8¼	..	..	..
285,045	Do. 5 % Pref., 1 to 57,009	5	..	5%	5	5 %	6⅛ — 6⅜	6⅛ — 6⅜	..	..	..
89,955	Do. 57,010 to 75,000	5	..	..	..	2½‖	6⅛ — 6⅜	6⅛ — 6⅜	..	..	..
10,852	Notting Hill Electric Lighting	10	6 %	6 %	7 %	6 %	13⅜ — 14⅜	13⅜ — 14⅜	..	..	..
59,000	Do. do. 4 % 1st Mort.Deb.	100	4 %	4 %	4 %	4 %	98 —100	98 —100	..	..	..
92,500	Oxford, 1 to 96 and 407 to 18,810	5	..	6½%	7 %	5 %‖	6⅜ — 6⅝	6⅜ — 6⅝	..	..	..
50,000	Do. 4 % Deb. Stock	100	..	4 %	4 %	4 %	100 —102	100 —102	..	..	..
40,000	St. James' and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	10%‖	12⅜ — 13⅜	12⅜ — 13⅜	..	..	..
20,000	Do. do. 7 % Pref. 30,081 to 40,080	5	7 %	7 %	7 %	7 %‖	8 — 9	8 — 9	..	..	..
150,000‖	Do. do. 3½ % Deb. Stock Red.	100	3½%	3½%	3½%	3½%	98 —100	98 —100	..	..	..
12,000	Smithfield Markets Electric Supply, Ord.	5	2½%	4 %	4 %	..	2 — 2¼	2 — 2¼	..	..	..
50,000	Do. do. do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	4 %	76 — 80	76 — 80	..	..	..
65,000	South London Electricity Supply, Ord.	5	1½%	3 %	4 %	..	3 — 3¼	3 — 3¼	..	..	..
100,000	South Met. Elec. Lt. & Power (Ord.	1	Nil	Nil	Nil	..	1⅛ — 1⅜	1⅛ — 1⅜	..	..	..
50,000	*(Late Blackheath and Greenwich* 7 % Pref.	1	Nil	7 %	7 %	7 %	1⅜ — 1⅝	1⅜ — 1⅝	..	..	..
100,000	*Dist. E.L.Co.)* 4½ % 1st Deb. Stk.	100	4½ %	4½ %	4½ %	4½ %	105 —108	105 —108	..	..	..
80,000	Urban Electric Supply, Ord.	5	5 %	5 %	5 %	5 %	4½ — 4⅝	4½ — 4⅝	..	..	..
80,000	Do. do. 5 % Cum. Pref.	5	5 %	5 %	5 %	5 %	5 — 5⅛	5 — 5⅛	..	..	..
200,000	Do. do. 4½ % 1st Mort. Db. Stk. Red	100	..	..	4½ %	4½ %	104 —106	104 —106	..	..	..
110,000	Westminster Electric Supply, Ord.	5	12 %	18½%	14 %	13 %‖	11½ — 12½	11½ — 12½	12⅛	11⅞	..
28,151	Do do. 5 % Cum. Pref.	5	5 %	5 %	5 %	5 %	5⅝ — 6⅛	5⅝ — 6⅛	..	..	..

Shares not officially quoted:—Mackay Companies, ord., 56—57. Pref. 74—76.
† Unless otherwise stated all shares are fully paid. ‡ Interim dividends.

Bank rate of discount 4 per cent. (September 28th, 1905).

EXPORTS AND IMPORTS OF ELECTRICAL GOODS DURING NOVEMBER, 1905.

As we surmised on recording the October returns of electrical business in these columns, the succeeding month of November has to some extent righted the balance between exports and imports.

Thus, while we cannot record any very substantial rise in exports, the amounts for the months in question being £109,102 and £110,252 respectively, yet a noticeable reduction has occurred in the imports, which totalled only £131,194 last month, as compared with £140,455 during October, a decrease of some £10,000 in value.

The re-exports remain practically stationary, at the high level of the previous month—amounting to £9,591, as compared with £9,871 during the month of October.

An unusual feature of the month's business is the high value of the cable exports; in regard to the imports, large reductions are apparent in the values of electrical machinery and telephonic material imported. No telegraphic material, specified as such, appears in the month's records.

Over the first 11 months of the year, it is satisfactory to note an increase in value of over £100,000 in electrical machinery exports as compared with the corresponding period of 1904.

Registered Exports of British and Irish Electrical Goods from the United Kingdom.

Country receiving exports and importing.	Electrical goods and appliances.	Electrical cable.	Electric lighting fittings and accessories.	Electric lamps.	Electric meters and instruments.	Electric machinery.	Batteries and accumulators.	Carbons.	Telephone material and electric bells.	Electrically-driven machinery.	Tramways apparatus and materials.
	£	£	£	£	£	£	£	£	£	£	£
Russia, Sweden, Norway and Denmark	95	...	28	291	35	521	63	...	117	61	...
Germany	78	86	6	20	...	21	20	...	25	...	...
Netherlands	58	252	680	16	...	578	...	...	...	...	...
Dutch Borneo, Java and Dutch Indian Possessions	26	...	64	11	12	57	...	...	...	...	...
Belgium	132	4	68	20	70	78	2	...	93	...	...
France	749	...	50	25	...	256	278	...	...	50	...
Portugal, Portuguese East Africa and India ...	507	1,300	224	17	30	2,161	58	...	20	...	...
Spain and Canary Isles	16	305	4	...	...	221	...	...	...	713	...
Italy	30	...	...	...	...	10	...	...	...	4	...
Greece and Bulgaria	...	8	...	3	...	100	...	...	...	...	...
Egypt	212	19	30	60	...	786	105	...	221	295	...
China and Siam	170	165	513	...	14	647	417	...	4	31	...
Japan	...	3,072	...	...	197	527	...	...	...	...	...
U.S.A. and Cuba	76	12	...	16	231	105	73	23	...	15	...
Mexico and Panama	...	917	36	...	...	5	10	...	...	...	...
Chili	118	...	132	151	219	2,479	126	...	...	...	...
Brazil	208	88	79	36	86	224	96	...	196	...	...
Argentine	1,082	2,614	410	906	124	2,445	924	3	490	2,541	...
Channel Isles, Gibraltar and Malta	188	1,634	16	...	...	43	...	...	...	...	...
British West Africa	...	182	6	...	...	19	...	...	...	...	...
Cape of Good Hope	288	1,385	2,123	252	45	1,631	96	9	108	248	...
Natal	2,047	2,053	1,836	1,511	250	5,304	49	...	58	1,026	...
British East Africa, Mauritius and Aden ...	90	44	61	...	36	...	...	13	96	...	...
India	2,717	5,697	2,656	436	1,230	5,782	104	...	38	2,569	226
Burmah	95	...	62	5	...	152	23	...	28	11	49
Ceylon	33	...	81	39	...	103	...	...	9	...	...
Straits Settlements	186	322	175	...	...	222	...	...	24	143	...
Hong Kong	116	811	63	...	...	1,348	28	...	...	68	...
West Australia	102	519	448	21	144	471	10	...	...	450	...
South Australia	...	224	95	...	...	166	26	...	...	461	...
Victoria	104	1,245	36	...	7	143	...	...	...	...	...
New South Wales	2,255	6,448	175	147	45	1,434	71	...	...	240	...
Queensland	...	18	9	...	...	1,525	...	...	...	...	...
Tasmania	...	...	6	...	...	110	77	...	...	...	...
New Zealand	861	3,682	440	77	187	528	23	...	2,380	...	...
Canada and Newfoundland	303	...	90	2	...	31	110	...	...	...	...
British West Indies and British Guiana ...	11	45	26	...	...	54	59	...	48	...	...
Total, £	12,978	33,151	10,730	4,062	2,962	30,317	2,848	48	3,955	8,926	275

Additional exports: French Indo-China, Fittings, £2; Morocco, Goods, £25.

Registered Imports into the United Kingdom of Electrical Goods from all Countries.

	£	£	£	£	£	£	£	£	£	£	
Russia, Norway, Sweden and Denmark	837	...	...	155	...	905	597	...	8,038	...	...
Holland	9,228	946	5,103	244	...	674	...	6,016	...	...	...
Germany	9,540	6,446	213	1,233	135	10,024	310	319	1,675	...	...
Belgium	12,031	745	42	4,343	4	12,369	81	870	1,648	...	...
France	8,099	1,157	1,274	67	432	2,220	693	2,220	...	...	...
United States	5,129	1,563	268	587	...	9,528	104	18	...	933	...
Canada	...	...	...	...	...	2,118	...	...	...	...	...
Total, £	44,864	10,857	6,900	6,629	571	37,858	1,785	9,443	11,361	933	...

Additional import: Cape of Good Hope, electrical machinery, £13.

Registered Re-Exports of Foreign and Colonial Electrical Goods from the United Kingdom.

	£	£	£	£	£	£	£	£	£	£	£
Various countries, mainly as above	1,602	...	176	...	80	1,443	186	167	5,932	5	...

Total Exports:	Total Re-Exports:	Total Imports:
£110,252	£9,591	£131,194

Note.—The amounts appearing under the several headings are classified according to the Customs returns. The first and third columns contain many amounts relating to "goods" otherwise unclassified, the latter, doubtless, consisting of similar materials to those appearing in adjacent columns.

THE SUPPLY OF ELECTRICITY IN PARIS.

An interesting report was drawn up by M. Picou for the Technical Commission of electrical engineers which considered the present and future working of electricity supply in Paris in February last. The Commission was appointed to inquire into the question on account of the fact that four of the six existing concessions expire early in 1907, and the remaining two in 1908 and 1912 respectively.

Owing to the growing demands upon the various companies, they found it necessary to erect generating stations in the suburbs, and to feed sub-stations therefrom; the sub-stations being in several cases side by side with the original stations. As the demand is constantly increasing, a thoroughly organised and uniform system is required to meet it satisfactorily.

The general progress of the various electrical undertakings has been very marked, notwithstanding the high price charged per unit, which charge is none the less for the restrictions and conditions imposed upon the concessionaires by the authorities. As compared with a gas company, which can always run the works at full load, the electricity company has to provide machinery for the peak of the load, which is much in excess of the average load, thus adding to the capital, sinking fund, and other charges to such an extent that the Commission considered an 18 years' concession, as at present, to be of too short a duration, and recommended the time to be extended to 35 years.

Owing to the short length of the current concessions, there was no incentive to the companies to bring their plant up to date, and they rely upon old-fashioned steam engines, which are not conducive to low generating costs.

The points claiming the attention of the Commission were production, distribution, price per unit, and system of charging for energy.

As regards generation, the consumption is assumed to reach 80,000 kw., and the Commission agreed without hesitation in giving preference to 5,000-kw. turbo-generator units established in three suitably situated generating stations; for the supply of water for condensation, the canals of St. Denis and St. Martin and the River Seine are available, but the latter alone can furnish the necessary quantity, as the Commission does not favour cooling towers owing to their unsightly appearance, their cost and to the fact that their depends somewhat upon the hygrometric state of the air.

The generators would produce three-phase current, which would be fed to sub-stations at from 8,000 to 12,000 volts between conductors.

For distributing the energy the problem of choosing the best system is rather involved, and the Commission endeavoured to disturb existing consumers as little as possible consistent with efficient distribution; thus in the central area direct current has been decided upon, and in the outer districts three-phase current.

As to the voltage of d.c. supply, the Commission recommended the maintenance of a 110-volt supply, which is the same voltage as now exists on two, three, and five-wire systems in Paris, notwithstanding all the various advantages of a 220-volt service, as consumers will be put to no "changing-over" inconvenience thereby, while the existing mains can be used, and the efficiency of lighting with arc and glow lamps is greater. The transformation from a.c. to d.c. will be effected by motor-generators in suitably situated sub-stations.

For the outer districts alternating current will be used, with transformer sub-stations, because the density of consumption is not great enough to justify the greater expense and lower efficiency of converter sub-stations. The a.c. supply to consumers will be on the three-phase four-wire system with 110 volts between the wires, and a frequency of 50 cycles per second. The primary distribution in both cases will be carried out with three-phase current at a pressure between 800 and 1,200 volts.

In considering the rate at which the energy should be charged for, the Commission allowed the life of boilers to be 10 years machines 15 years, buildings 35 years, and cables 35 years; and for a maximum estimated demand of 70,000 kw., it was considered that 100,000,000 fr. would be necessary, the annual charge for interest and redemption of this sum in 35 years being 6,000,000 fr., the charge for renewal of plant 3,165,750 fr., and generating expenses 8,116,600 fr. annually.

The mean price per unit agreed upon was ·329 fr., assuming a use of the installation for 750 hours per annum. For 400 hours or less the rate would be ·593 fr., and for 3,000 hours and upwards ·165 fr. per unit, the rate charged depending upon the duration of utilisation of the installation. The figures take no account of profits or of municipal taxation.

Finally, the opinion was expressed that, when the new programme was realised, osmium and tantalum lamps would make electricity as cheap as gas.

The question has now entered upon a new phase. Last month, as reported in *La Revue Electrique* of the 15th inst., the Prefect of the Seine laid before the Municipal Council the proposals which had been submitted by the various companies for the realisation of the scheme for the unification of the supply. Three of the six sectors offered terms which met with little favour, and did not satisfy the conditions laid down by the Commission. The other three, however, and an outside syndicate, brought forward propositions embodying entirely new features, which engaged the serious attention of the authorities. Each of these took into consideration the permanent as well as the transition stage, though the first three dealt only with portions of the area to be supplied. The fourth, which was put forward by two firms, Messrs. Schneider and Co. and Messrs. Mildé & Co., applied to the whole area, and was the only one recommended to the attention of the Council by the Prefect of the Seine.

Dealing with this scheme alone, therefore, it appears that the new company proposes to commence operations in each sector directly the corresponding concession expires, and guarantees the city against any difficulties which might arise between it and the sectors. The concession asked for would expire with the year 1938, but would be terminable at the end of 1923, 1928 or 1933. Up to the end of 1912 the company would carry on the service, utilising the existing installations as far as possible; at that date the last of the concessions would fall in, and the company would proceed to carry out the dispositions indicated by the Commission. The company would pay to the city 8 per cent. of the gross receipts from the sale of energy, and 45 per cent. of the annual profits, engaging to make up the total payment, in any event, to 4 million francs per annum at least. On the expiration of the new concession, the whole of the assets would pass to the city without payment. The tariffs would be reduced at the expiration of each of the existing concessions, and a reduction would be made to the city of 30 per cent. on the general tariffs. The charges, up to the end of 1912, would not exceed 0·90 fr. per unit (peak load), and 0·35 fr. (day load); thence up to 1923, 0·70 and 0·20 fr.; for the remaining period, 0·60 and 0·15 fr. per unit. Consumers would have the choice of the double tariff mentioned above, or the maximum demand system, and a reduction of 25 per cent. would be made to consumers taking their supply direct from the primary mains (after 1912). The tariff proposed by the company cannot be directly compared with the others, but it seems that the mean price for lighting will be 0·60 fr. per unit at the start, while for motive power the charge per kilowatt-year from 1913 to 1922 will be 4,500 fr. and afterwards 3,000 fr., working 10 hours a day.

It will be gathered from the foregoing brief particulars that the City of Paris has under consideration a project which, while differing in many respects from the Administrative County of London scheme of last session of Parliament, is still analogous to it in others. According to these proposals the City will benefit by a large annual rental, a greatly reduced tariff for electrical energy, and by a uniform system of supply, while after the expiration of 33 years from date, the Municipal Council will enter upon possession of a vast undertaking entirely free of cost. All negotiations with the existing concessionaires will be handled by the new company, which will be solely responsible for the electricity supply of the City. The advantages to the City are beyond dispute, but, as our contemporary shrewdly remarks, the mulish spirit which too often prevails in the Municipal Council may regard the recommendation of the Prefect of the Seine as a reason for the rejection of the scheme—a remark which will be only too keenly appreciated by those who dwell under the ægis of the London County Council. Let us hope that the Municipal Council of Paris will set a wise example to its good friend of London.

PROCEEDINGS OF INSTITUTIONS.

INSTITUTION OF ELECTRICAL ENGINEERS.

Discussion on Paper by Mr. W. H. Patchell, on the Charing Cross Co.'s City of London Works.

The discussion was opened by **Mr. Carl Sulzer**, who congratulated the author on the success of his work.

Mr. C. P. Sparks drew attention to the fact that Ferranti had forestalled the author in the matter of direct generation and transmission underground at 10,000 volts pressure. The author had not been able to trace the presence of nitric acid in his high-tension machines; he (the speaker) suggested thorough impregnation of the coils at an early stage of manufacture, so as to exclude the air, as all that was necessary. The safety of extra high-pressure cable systems was very great, and no depreciation would result if all moisture were excluded. He, however, considered it a mistake to lay cables "solid" in the City of London; a drawn-in system was more convenient. In his opinion, the generating station might have been advantageously placed further out than Bow, having regard to the prime necessities of coal and water. The author's boiler plant was of great interest, and his steel chimneys the speaker envied. He, in common with other speakers, would have liked actual figures of coal consumption, &c., as if the latter was slightly over 3 lb. per unit, it was a good result, while nearly 4 lb. was not good enough with Welsh coal. In his company's station, which was about one-fifth the size of Mr. Patchell's, the consumption per unit generated was 4½ lb. of North-Country slack, but the plant was older and the coal dearer there. Mr. Duddell's oscillographic tests at his own station had been of great value, and it was shown that the oil-break switch, breaking at the neutral point, was the only reliable one at high pressure; the same was true of oil fuses.

Mr. J. S. Highfield drew attention to the fact that at Willesden the two-phase plant was operated at 11,000 volts to earth and 15,000 volts between phases, whereas the Bow plant was three-phase with the star centre earthed, involving only 6,400 volts pressure to earth from any phase; this was one advantage of the three-phase system. He did not find any appreciable difficulty in switching in or out 7 miles of main without any charging gear. Discussing the formation of nitric acid in high-tension machines, he did not think that there was any way of making mica tubes stand, except by making the coils air-tight. He considered that a pressure of 11,000 volts above earth was nearly the maximum for use in this country.

Mr. W. H. Booth suggested that the interesting features of the paper lay in what was omitted. Referring to the boiler plant, with

Welsh coal and hand firing, there must be smoke at times. The idea of the secondary grate was a good one, but how were the secondary fire doors kept air-tight? He did not think that the back sections of tubes in the vertical type boiler would act as an economiser; in fact, the back and front would be approximately at the same temperature, and the waste gases would escape at about 600° F. The lack of an economiser was also a serious matter. He considered that the system of feed heating adopted would add little to the temperature of the water if a low vacuum was obtained in the condenser. The superheaters were too far above the boiler furnace to be of benefit, but they could not be nearer owing to the risk of burning. The coal used seemed to be about 4 lb. per unit; he contrasted this with the results obtained from a factory type of engine, which was fitted with a reheater between the H. and L.P. cylinders, in connection with which, apparently, a form of controllable superheater was used. In the latter, the I.H.P. was 348, the steam being superheated to 495° F.; the result of the system adopted was a reduction of 200 tons on the 730 tons previously used per annum, or a reduction of from 1·8 lb. to 1·4 lb. of coal per I.H.P.-hour. Such a system gave much better results than the ordinary methods of steam raising adopted in large plants.

Mr. J. H. RIDER commented on the lack of important data in the paper, and on the author's choice of a power station site; in regard to the latter he could have gone further out, say, to a river site, with advantage. He could not understand the choice of 50 cycles, and 25 cycles would have been better, if conversion to direct-current was contemplated. The speaker further challenged the statement that extra switchgear would have been required with static transformers; in that case there was only the H.T. gear on the primary side of the transformers, and the L.T. gear on the D.C. side of the motor-generators. The boiler plant was most interesting, but the absence of machine stoking was surprising; the double grates were excellent for emergency loads. He criticised the feed water arrangement for its unnecessary complication; the author could have arranged to pump direct through the feed heaters to the boilers, and have avoided the loss of heat through the water standing in the hotwell. If the author was depending on his two artesian wells for boiler feed, he appeared to be getting near the limit of their capacity. He (the speaker) had a similar well at the Greenwich power station, which, however, necessitated the use of water-softening plant. He asked whether the author went abroad for his plant on the score of cost or of efficiency, or both, as it appeared to him that it could have been equally well obtained in this country. He agreed with Mr. Highfield that cable-charging apparatus could be dispensed with if suitably insulated cables were employed; the use of a motor-generator for such a purpose introduced difficulties owing to its having to be run up and synchronised like an ordinary generator. The author would, in the speaker's opinion, have saved in cost by adopting a drawn-in system for his trunk mains. He had now superseded the cable joints described by linen taped joints, the tape being wrapped between the leads. He congratulated the author on his using H.T. current direct on the stators of his motor-generators, but considered that induction motors were simpler, both in themselves and their switchgear, than synchronous machines. Simplicity should be the great feature of such plant, and commercial efficiency was the end to be attained. He concluded by appealing to Mr. Patchell for details of the cost of operation and of the plant, which would be more valuable than the paper itself.

Mr. A. VENNING remarked on the large proportion of boiler power to engine power installed, and suggested that the crane might have been placed higher up, and so have given greater facility for dismantling the 4,000-KW. generators. He proceeded to criticise, at length, the design of the Hornsby boilers, comparing them with the Stirling boilers installed at Carville, to the advantage of the latter as regards output and floor space occupied. He did not see how economisers could be added, as suggested in the paper.

Mr. A. C. ANSTEY (of Hornsby's) discussed the greater evaporative activity of the boiler tubes nearer the furnace; some 25 per cent. of the total evaporation of the boiler took place in the tubes next the fire. The rate of working had a great effect on the life of the tubes, as it is easy to get dangerous rates near the furnace. In the plant at Bow, after 15 months' working, the tubes near the furnace were quite straight. It was quite easy to fit machine stokers to the furnaces if desired. He further drew attention to the large volume of the combustion chamber in the vertical type boiler, in which, when working at a high rate, but little over 1 lb. of coal was burnt per cubic foot of combustion space. This figure was, however, increased four times in the horizontal type of boiler with its smaller combustion space. The upright boiler unit could be worked at up to 130,000 lb. of water per hour if the draught was improved. In conclusion, he assured his hearers that a definite circulation was obtained in the back portions of the upright boilers, which parts did act as economisers.

Prof. J. EPSTEIN (of Messrs. Lahmeyer) described experiments carried out by his firm with a view to absorbing the gases in stator windings; they found, however, that the insulation provided on the machines was quite sufficient to withstand anything which might occur. He considered that the three-phase system was preferable to the two-phase, as used by the Metropolitan Co., and that a periodicity of 50 cycles was in this case better than 25.

Mr. W. M. MORDEY agreed with the last speaker in regard to the periodicity; with 50 cycles, it was possible to carry out electric lighting without the use of rotating machinery, if desired. Motor-generators could also be used with less risk of variation in the secondary pressure. In regard to the deterioration of insulating material supposedly by the evolution of nitric acid, with alternating currents at high pressure, it was interesting to note that preparations were being made on a large scale to obtain nitrogen compounds from the air by electrical methods. He, however, suggested from his own observations, that the disintegrating action on the insulation observed by Mr. Highfield might be due to the actual hammering which occurs between conductors, from statical causes, in large alternating current generators. This would account both for disintegration and heating; and it also made them realise how very important were the engineering as distinct from the electrical problems of electrical engineering.

Mr. H. M. SAYERS, referring to Mr. Highfield's remarks on the presence of nitric acid in large generators, mentioned that he had had trouble with an alternating current network owing to deterioration of the cables near earthed metal; this was stopped by providing a lead sheathing. With regard to the author's boiler plant, machine stokers would enable bituminous coal to be used equally as well as Welsh. The objection to surface condensers, suggested in the paper, was probably scaling of the tubes; the latter, however, could easily be cleaned by treating in a bath of hydrochloric acid. Such scaling was largely due to the use of cooling towers, which tend to concentrate the salts in the water, and the concrete reservoirs used under the towers also gave off lime salts. The proper remedy was to soften the make-up water.

The discussion was adjourned to January 11th, 1906.

MANCHESTER STUDENTS' SECTION.

The opening meeting of the students of the Manchester Section was held on Friday evening the 23rd ult., in the Manchester School of Technology. Mr. S. L. Pearce presided. Owing to unforeseen circumstances, Mr. Swinburne was unable to be present, and his address, which was entitled "Efficiencies," was read by the secretary, Mr. D. L. Sands.

In the opening part of the address the author explained the question of efficiency from various points of view of machines, trader and seller. He remarked that a trader who looked upon buying at 15s. and selling at £1 as making a profit of 33 per cent. would be really deceiving himself, because the question was not how much he made over the apparent purchase price, but what profit he made per annum on his trade capital. Into this question all sorts of considerations entered. If he was a trader he had to pay rent, incur bad debts and losses through depreciation and other causes, and had to give his time to the work. Many unpractical people thought a man ought to sell goods for a small percentage above what he paid for them. If an engine builder paid £1,000 in wages, and £1,000 for material, to build an engine, and sold it for £3,000, it was commonly said he had no business with the odd £1,000; he had either overcharged his customer, or had robbed the workmen. These notions arose from ignorance, and did a great deal of harm. He next explained by diagram the losses that occurred in steam boilers and engines, and in a small installation with secondary batteries.

The losses between the station and the consumers' terminals were made up of different details, according to the method adopted of transmitting the power. A diagram was given showing the yearly losses in the Metropolitan system, prepared from figures supplied by Mr. Highfield, from which it was seen that the transformers were very efficient, and when they could be cut out at light loads so that the transformers in use were always well loaded, the efficiency was very high. There was a loss of 6 per cent. in the station, only 2 per cent. in feeders to sub-stations, and 13 per cent. in conversion and the lighting of sub-stations. The figures were for a year, but varied, however, from time to time. Thus the station losses were 7 per cent. at noon, 4 per cent. at top load, and 20 per cent. at 3 a.m. Though the various sources of waste varied, the final result was 79 per cent. efficiency at noon, 74 per cent. at 6 p.m., and 65 per cent. at 3 a.m., which was very good, all things considered.

The question of accounts was next considered. These depended on whether it was a municipal undertaking or a company. If it was a company, interest was really part of the profit, but the depreciation should be large enough to allow for the gradual reduction of the value of the plant. If the station was run by a town the accounts were kept on an absurd system. The town did not save money like the private individual, and then buy what it could afford; it had to borrow money for everything, and pay it back over a term of years. The length of the term had no reference whatever to the nature of the work done, as the work was not in any way security for the loan, the local rates were the security. For a private individual always to be in debt would be bad; for a town it was another matter, the only question was how much the town ought to be in debt.

Local authorities were taking up such businesses as electric supply and tramways, which had profit and loss sides, but they were obliged to work on the same lines as town improvements, which was absurd. Municipal electric light schemes were thus worked under absurd difficulties. They were like a public company that had a negative capital, *i.e.*, all its money was borrowed. The ratepayers were the shareholders, and held shares depending on the rate assessments. The dividends were generally negative. The town might only borrow enough money to put down the plant. This had to be paid off by sinking fund which returned the money in, say, 20 years. The plant might last 10 years, or it might last 50; that had nothing to do with the case. On the other hand, a private concern would start business with enough capital to put down the station and run it at a loss for a year or two until it had turned the corner. The municipality might not do anything so sensible as that, and for the first few years losses had to be paid out of the rates, a proceeding which sometimes excited the rate-

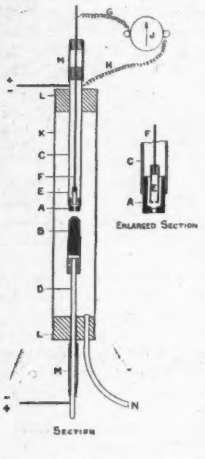
payers. Any business had to be run at a loss at first, and if enough capital was provided to meet the deficit, when the business paid it ought to pay on the whole capital.

On the subject of tramway accounts, attention was called to the very small proportion paid for power, under 3 per cent. Traffic expenses were ten times more, and depreciation and renewals 20 per cent. This was in addition to a sinking fund of 6 per cent. (This was 6 per cent. of the money received for tickets, and must not be confused with a 6 per cent. sinking fund.) There was a net profit of 14½ per cent. (on money taken, not on capital).

The proceedings closed with a vote of thanks to the author.

TRANSIT OF IONS IN THE ELECTRIC ARC.

We have received from Mr. A. A. Campbell Swinton a copy of a paper communicated by him to the Royal Society on the above subject. The paper describes an experiment performed to demonstrate the passage of the positive ions from one carbon to the other, and of the negative ions in the opposite direction. Referring to the figure, it is seen that one carbon, A, is arranged so that some of the ions projected from the other carbon, B, can pass through a small hole in the centre of A and pass into a small cell or tube, E, which is insulated from A. The charges conveyed to E then pass through the galvanometer J, to the carbon A, and deflect the galvanometer. At first Mr. Swinton was only able to obtain the result he sought by exhausting the air in the neighbourhood of the arc, enclosing it in a large glass tube K: since at full atmospheric pressure the velocity of the ions projected from B fell off too rapidly to allow them to pass clear through the small aperature in A and enter the cell E. A moderate degree of exhaustion, however, showed the effect he looked for, and the direction of the galvanometer deflection showed that the charges that reached the cell E, were in each case of the same sign as that of the opposite carbon B, whether positive or negative.



A footnote to the paper mentions that the author had been able subsequently to obtain the same results at ordinary atmospheric pressure by using rather larger apparatus.

The author obtained larger deflections when the carbon B was negative than when it was positive, thus confirming the known fact that the negative ions in the arc have a greater velocity than the positive ions.

THE FARADAY SOCIETY.

The Flotation Process for Concentrating Ores.

The December meeting of the Faraday Society, which was held on the 12th inst., was chiefly devoted to the discussion of the theoretical aspects of certain flotation processes for the separation of ore from gangue, which are now being largely used in Australia for dealing with the famous, or, perhaps, infamous, Broken Hill tailings. Some of these flotation processes, notably those of Potter and Delprat, have been exciting considerable interest during the past year or two in "patent" and "expert" circles, owing to troublesome questions of infringement which have arisen, but which being still *sub judice*, we must not discuss at present. But apart from the legal aspects of the processes, the physical principles underlying them are of the greatest possible interest, and seeing that there might in the near future be unlimited scope for their application, the elucidation of their theoretical aspects becomes a matter of real and immediate practical importance, as well as of academic interest. We hope and believe that the day has long passed, when practical men were content to know merely *how* processes worked, without understanding at all *why* they worked. The subject was introduced by Mr. J. Swinburne and Dr. G. Rudorf, who dealt chiefly with what they called "The Physics of Ore Flotation," while Prof. Huntington in his paper entitled "The Concentration of Metaliferous Sulphides by Flotation," dealt rather with the experimental and practical sides of the processes.

The processes as applied, for example, to Broken Hill tailings, which contain from about 25 to 35 per cent. zinc blende (ZnS) intimately mixed with anything up to 7 or 8 per cent. argentiferous galena (PbS.) with small quantities of calcite, the carbonates of iron and manganese, and a great deal of siliceous gangue, consist in adding a dilute solution of either sulphuric acid (Potter) or acid sodium sulphate (Delprat) at a temperature of 65° C. Under these conditions, bubbles of gas are evolved (we shall presently discuss what they consist of), and these bubbles, in rising to the surface, carry up with them the valuable sulphides of lead and zinc, where they form a coherent and easily removable scum, while the useless gangue is left behind at the bottom of the tank. It may seem extraordinary, and even incredible, but in practice the separation is clean and complete to the point of being quantitative.

The first question to consider is, What is the gas which is evolved? It used to be thought that sulphuretted hydrogen could claim that credit, but that has now been ruled out of court, and experiments described by Prof. Huntington, prove without question that the bubble carriers consist of carbon dioxide, and that this is produced by the action of the acid on the carbonates of iron and manganese present as impurities in the ores.

The next question, How do the gas bubbles get into close contact with the solid particles of ore? is, we are afraid, one that has not as yet been satisfactorily answered. Electrostatic attraction (it is known that the CO_2 produced is electrified) has been suggested, and Prof. Huntington devotes some space in his paper to the consideration of this explanation; but it is impossible to imagine how such attraction can exist in a conducting liquid. Mr. Swinburne and Dr. Rudorf suggest that it is necessary for the gas to be actually produced on the surface of the metallic sulphides, but the separation is too clear to allow that this can always be the case, and in any case experiments quoted by Prof. Huntington prove that this condition is not by any means necessary. Perhaps the most promising solution of the problem was that foreshadowed—rather than explained—by Mr. John Rhodin in the course of the discussion. Dismissing as dynamically unthinkable, the possibility of the gaseous particles impinging against and breaking through the envelope of liquid immediately surrounding the solid particles, Mr. Rhodin thinks that the application of the law of mass action, suggests the possibility of gas being evolved in the body of the liquid at a distance from the active carbonates, which are a function of the solubility of the latter. With calcium carbonate this would be exceedingly small, and hence the poor separation obtained when calcite alone is present in the ore. Put in another way, this explanation supposes that the heterogeneous system $FeCO_3$, H_2SO_4, H_2O, is in equilibrium within the sphere of saturation of the carbonate, and that the transition point of the reversible reaction $FeCO_3 + H_2SO_4 \rightleftarrows FeSO_4 + H_2O + CO_2$ is somewhere about 65° C. The fact that ordinary soda water which, of course, evolves gas anywhere in the liquid, is effective in causing flotation of stibonite, lends colour to this interesting hypothesis of Mr. Rhodin. The alternative suggestion that small local couples, $FeCO_3$, metallic sulphide, H_2SO_4 bring about electrolysis of any H_2CO_3 in the solution is, we fear, untenable, as the presence of conducting carbonates is not necessary for the flotation—iron carbonate is itself a non-conductor.

Once the bubbles of gas have come into contact with the ore particles, the explanation of Mr. Swinburne and Dr. Rudorf makes it perfectly clear how it is that the metallic sulphides are lifted. Consider the case of an immersed particle of ore in contact with a gas bell. We have two capillary effects to bear in mind, the adhesion forces between solid and liquid, and the surface tension at the free surface of the liquid. The latter tends to make the surface of the liquid as small as possible consistently with its still containing the air, and it will cause a bubble to surround a contiguous solid particle, as far as its size will allow. If, therefore, there were no adhesion, and the ore particles were small enough and light enough, they all would rise with the bubbles. But adhesion, tending as it does to immerse the solid particle, acts in the opposite direction, and so prevents the solid from being raised.

Fig. 1.—High Angle of Contact. Fig. 2.—Low Angle of Contact. Fig. 3.—Solid Completely Wetted.

Gas Bubble in Contact with Solid.

Perhaps the effect can be made more clear from the diagrams drawn by Prof. Huntington (see figs.). Prof. Huntington's explanation, however, that whether a given substance can be floated or not depends on the angle of contact which the solution makes with the substance at the free surface supplied by the gas bubbles, requires some amplification. The statement is accurate as far as it goes, but it should be understood, as Messrs. Swinburne and Rudorf were particularly anxious to make clear, that this angle of contact is the resultant of the two opposing forces of "adhesion" and "surface tension." Adhesion, in figs. 1 and 2, tends to wet the whole of the solid, and so *reduce* the contact angle at the free surface to zero. Surface tension, on the other hand, would like to enclose the solid in the bubble (in practice, of course, the solid is not "infinite," as shown in the diagrams), and so *increase* the contact angle at the free surface. Now in the case of sulphide particles the adhesion is small; they are "greasy" in popular language, the angle of contact is large in mathematical language, and so under the proper conditions of weight, size and temperature, they may be lifted. On the other hand, the gangue is easily wetted, and therefore "adhesion," having the better of "surface tension," the valueless quartz kindly refuses to be floated. The problem is, however, not quite so simple as all this, because an uncomfortable complication is introduced by the condensed air-film which exists on the surface of all solids, and which can only be got rid of with infinite difficulty, if at all. It may be that this air-film is more persistent, or is of greater magnitude in the case of "greasy" particles (stibnite and molybdenite have enough air on them to float them in boiling water without any external source of supply), and so assists the bells of CO_2 to become attached, but be that as it may, there is no doubt that the essential quality which determines the separation is the comparative "greasiness" of the various constituents of the ore under the temperature and other

conditions at which the action is carried out. As to why sulphides should be "greasy" and quartz not, as well ask why glass should be a dielectric and copper a conductor.

The Conductivity of Pure Water.

It is well known that the purer one is able to get water, the less is its electrical conductivity, and it has long been supposed that absolutely pure water, could it be prepared, would be a perfect insulator. Prof. James Walker, F.R.S., in his paper "The Ions of Pure Water," now finally disposes of that notion and shows, from a consideration of temperature coefficients, that even pure water has a real conductivity of its own, due to ions of hydrogen, H, and hydroxyl, HO. As the delinquents principally concerned, Dr. Lowry and Mr. W. R. Bousfield, now fully agree with Prof. Walker, we must assume that his position in this controversy is now completely vindicated, and that on one small application, at least, of the dissociation hypothesis, all authorities are in full and complete agreement.

BOILER HOUSE ECONOMY.

Notes on a Paper read by Messrs. Alfred W. Bennis *and* W. E. M. Carnock, *before the Engineering Society, Huddersfield.*

In regard to the question of fuel economy, manufacturers and engineers have in the past shown an inclination to consider fuel economy as spelling steam economy at the engines. The work of the late Mr. Bryan Donkin has educated those engineers who cared about boiler efficiencies, but the education of the manufacturers has hinged on the gentle art of advertising. The latter, therefore, have been the hunting ground of the salesmen of boiler accessories manufacturers, and have from time to time been induced to install certain apparatus for dealing with the heat losses taking place in one particular part of the boiler house. Very few manufacturers indeed would care to call in a competent engineer to revise the whole of their steam-raising plant. Yet true economy in steam raising is not a mere matter of somebody's patent fire bars or of somebody else's patent lagging, or even of another party's method of heating the feed water, but consists in a wise selection of accessories, coupled with the careful designing and laying out of the installation.

That, but not in the words used above, may be said to be the moral which the authors of the paper now before us sought to impress on their hearers. The paper itself cannot be reprinted at length in our pages—the pressure on our space is heavy, and the paper itself has the air of a general elementary exposition of principles which every engineer responsible for the management or design of a boiler house should have mastered. Some lessons have in the past fallen on idle ears, therefore we reprint (of course for the sake of the unconverted only) some notes concerning boiler house design.

The authors' enumeration of the points where losses in heat may be expected is a fair one, although chimneys such as that mentioned in the first of the following clauses have not come within the range of our own experience:—

1. Badly-designed flues or chimney causing bad draught. In cases of this kind we have known the chimney to take 25 per cent. of the coal to keep up its bad draught.
2. Leaky brickwork in flues or chimney.
3. Paying too much for your coal, through not knowing its calorific value.
4. Low temperature combustion, and consequent inefficient heat transmission.
5. Using a high-pressure boiler for low-pressure work.
6. Avoidable radiation losses through more boilers being in service than necessary.
7. Inefficiency or lack of boiler, steam and feed-water pipe covering. A reasonable return can be made, even if it costs 1s. per sq. ft. for covering. Experiments we have made show that each square foot of steam or boiler uncovered surface wastes on an average 10 cwt. of coal per annum.
8. The excess of air necessary in low temperature firing to keep down smoke.
9. Reducing the air supply too much, through misinterpretation of the data furnished by gas analysis apparatus.
10. The want of enough heating surface in economisers.
11. High terminal gas temperatures due to prolonged combustion in hand and other inefficient furnaces.
12. Scaly and dirty boilers, economisers, &c.
13. No spare boiler, no time to clean, &c.
14. Leaky steam traps. Arrangements should be made so that the outlet is always visible, when leakage can at once be rectified.
15. Wasteful pump and auxiliary plant.
16. Coal and ash-handling costs too high.

In regard to chimneys, the authors described the ideal chimney as having a height not less than 120 ft., and unless there were special reasons for it, not more than 180 ft. The entrance should not be straight, but the last foot or so should be inclined at an angle of 45° upwards, and the area at the entrance should be 10 per cent. extra to limit loss of draught due to friction at this point. Areas of flues and economiser chambers were also discussed, and it was stated that, with regard to the walls of the latter, the bricks should be covered with mortar.

Concerning checks on the fuel used, the authors remark that "it would be a step in the right direction towards effecting boiler house economy, if, when an automatic conveying plant were installed in a boiler house, or elsewhere, automatic sampling arrangements formed a necessary part of the installation." Continuous calorimetric tests of the coal were recommended, with the analyst in reserve for consultative purposes when placing coal contracts. As might be expected, much was made of the fact that well-designed mechanical stokers could burn relatively low-grade coal, unsuitable for hand firing.

Passing next to the transference of heat through boiler plates, reference was made to Blechynden's experiments, and from these the practice of using plates fit to stand 200 lb. pressure per sq. in. for boilers working at 150 lb. was condemned. The authors were on safe ground when they urged that boilers should "be worked at their full capacity," and that it is best "to have as few boilers at work as possible." Such a counsel of perfection as this, applies to textile or paper mills with their steady loads. Central station engineers with heavy peaks in their loads are unable to work on these lines.

Messrs. Booth and Kershaw in their I.E.E. paper have said all that can be usefully said on flue gas analyses, so that the remarks made on this subject by Mr. Bennis and his co-author need not be repeated.

Passing on to hand *v.* automatic firing, a perhaps tenable parallel was drawn between the continuity of the supply of steam to an engine, and the intermittent supply of fuel to the furnace grates with hand firing. Different types of automatic stokers were discussed, but every student knows (or ought to know) the differences between coking and chain-grate stokers. The paper was illustrated with photographs and descriptions of various installations, such as those at the City Road and Bankside stations with their elevating and conveying machinery, and the Avonbank station at Bristol. The final example was that at Martin, Sons & Co.'s works at Huddersfield, concerning which the authors (merging their identity in the first person singular) said—"There is, perhaps, what I might call one of the most 'up-to-date' plants in this country. I believe I am correct in stating that they were the first to make use of an ordinary municipal tramway to bring their fuel in. Tramway lines have been run from the main road right into the works. A special form of side door electric tramway truck was built by Messrs. G. C. Milnes, Voss & Co., with Westinghouse controllers for the purpose.

"This electric railway truck, of which I am able to show a view to-night, brings the coal in and deposits it, as depicted, over a coal hopper. This hopper is formed of cast-iron plates supported on joists, which are let into the brick walls for forming the hopper pit. A 'Bennis' steel chain conveyor runs through this coal hopper, taking up the fuel at an angle of inclination of 24°, and then running along over the top of the stoker hoppers, as shown in photograph.

"This combined elevator and horizontal conveyor does away with the necessity of providing a separate bucket elevator and coal conveyor. It consists of a channel-shaped trough made out of close, hard-grained cast-iron $\frac{5}{8}$ in. in thickness, strongly ribbed, 9 in. in width and 6 in. in depth. The conveyor chain consists of U-shaped links, made out of 2 in. × $\frac{1}{2}$ in. open hearth acid mild steel flats. The links are 12 in. in pitch, and secured at joints by means of specially constructed rivets and washers.

"The coal is distributed through the shoots into the mechanical stoker hoppers. The stokers are of the 'Bennis' make, with self-cleaning compressed air furnaces.

"Each of the distributing shoots is fitted with cut-off slides, so that the supply can be stopped in the event of any boiler being taken out of service.

"The conveyor chain is driven by means of a horizontal drum with drags in two spur wheel reductions.

"The whole of the plant, including the stokers, is driven by a slow-speed engine 8 in. cylinder × 9 in. stroke."

In an earlier part of the paper the authors speak of an efficiency of 85 per cent. when an economiser, a good mechanical stoker and a superheater are utilised. This claim is dealt with on another page of our current issue.

SMOKE ABATEMENT CONFERENCE.

Whilst we sympathise with the objects of the Coal Smoke Abatement Society, we cannot say so much for some of the methods pursued in their quest of the Holy Grail of ultimate purity of atmosphere. The worst offenders in regard to smoke are probably the householders, and the household fire we look upon as almost hopelessly past reform unless the intelligences and pockets of the people are both sufficiently furnished to adopt the expensive deep underfeeding hopper by which the domestic grate may be fed with coal from below. But the cure for the domestic fire trouble at present most obvious seems to be that advocated by Sir Charles Cookson and used by himself in his house in Cheyne Walk. Sir Charles simply uses coke, which gives a clear bright fire, and he overcomes entirely the lighting-up difficulty by aid of a gas burner, which is set alight for a few minutes only to ignite the coke, after which the coke burns freely of itself. This system is that which would be so easy to undertake were the gas engine to take the place of the steam engine, all bituminous coal being first carbonised and the gas used for power purposes. The residual coke would be available for domestic use, or it could even be made into producer gas, and the whole question of the domestic fire settled in favour of gas with due precautions as to suitable flues. It must be allowed that the manufacture of gas turns no black smoke into the atmosphere. Coke is the only fuel used in a gas works, so that, though our London fogs might be made, or rather kept, clean, they would still be sulphurous to the extent of the sulphur in the coke. They would not be creosote laden, however. The smoke nuisance has never appealed to the electrical engineer, who, though he keeps our rooms clean, may, perhaps, have no serious commercial objection to a fog, because a fog means day load and dividends, and

every unit of electricity implies the discharge into the atmosphere of the unconsumed fuliginous products of 4 lb. of coal and upwards.

Since electric lighting claims to stand for sweetness and brightness, it should be the duty of the electrical engineer to see to it that the furnaces he employs are not offenders. Every engineer knows, or should know, that there is one electric light station in London which burns bituminous coal without smoke, except, perhaps, when lighting up. Then, when the furnace is as cold as the boiler, smoke may be made, but is not this very complaint a clear proof of the correctness of the principles of construction employed? Now, if one station can do this, so can another. Yet, in face of known facts frequently referred to and vouched for, no other engineer departs from the commonest furnace practice.

We do not know if Sir W. Richmond and his friends are aware of these things. We incline to doubt whether they do; to us they appear rather to take up the attitude of Gallio, who cared for none of these things. But if they do know of them they might almost be justified in this attitude, resolving that if engineers will not adopt known and economical methods of clean combustion, so neither need they trouble themselves further than to set in motion the Smoke Acts to the utmost of their powers. Why, they may well argue, need we go out of our way to instruct these coal burners, who will not give ear to their own fellows?

We are sorry to say that Sir Oliver Lodge was prevented from attending to give an address, but his prepared notes were in the hands of Sir W. Richmond. We cannot agree with Sir Oliver that the steam boiler acts most efficiently when its surfaces are smothered in soot, or, to quote the words of the report, "the conditions which best favoured heat transmission were exactly those which favoured the production of smoke and flame in the furnace of the boiler." There are no good grounds for this statement, for it has been shown time and again that correct furnaces are as efficient as smoky furnaces. The drift of the Society seems to be to force on the use of gas power rather than to compel the use of proper boiler furnaces. Why the long-drawn-out nuisance at Neasden was permitted to go on can only be attributed to the very grave objections to stopping the working of the railway. But why should any steam producer be allowed to put down furnaces which are *ab initio* so hopeless as those at Neasden must obviously have shown themselves to be to any expert who might be shown the drawings? Why should there not be a public examiner with power to condemn boiler furnace plans when obviously hopeless, still leaving the onus of even accepted plans upon the undertaker?

Space in a furnace is not, *per se*, a guarantee of smokelessness in the absence of correct movement, air mixture, and suitable other requisites. Messrs. Hornsby's representative, who spoke at the Institution of Electrical Engineers' meeting on behalf of a plain vertical furnace without a brick arch, and with no provision for proper air and gas mixture, was understood to say it was when referring to the furnaces of the boilers mentioned by Mr. Patchell. Mr. Rider also appeared to support this view, which is certainly erroneous. The high furnace with three brick sides, and with an arch over the fire, will be better than the common horizontal furnace, but Mr. Patchell does not himself believe in them in the form he has adopted, to the extent of cutting down what must be the heavy expense of Welsh coal. But there is room for a brick arch, and this will pay for itself in the coal economy.

The basis of a London fog is mist. This can never be done away with. Mists are more or less common to all river valleys, and more particularly where the surface is clay, as in the Thames Valley for 40 miles above London. A London mist is the product of a rapidly reduced temperature and a high barometer; these are at least the usually concomitant natural phenomena. But a moisture-charged atmosphere is of low specific gravity, and coal smoke cannot rise through it, but remains below and produces fog, sometimes, as we see, a mere yellow transparent smoke fog when the mist is high and blankets down the smoke, but more often the dense black fog caused by mixture of smoke with the thick mist. The curious incongruity of a high barometer with a moist air of low specific gravity is, of course, due simply to the fact that the misty stratum often extends upwards from the earth's surface but a few feet. But a fog only 10 ft. high is equally obstructive with one of 100 ft.

It is a very lame conclusion for engineers to speak of smoke prosecutions as persecution. The remedy is in their own hands, if they would only use it. It is all a matter of design that some engineers have solved and others refuse to acknowledge, though why the latter it is difficult to see. In anything patented, or that has once been patented, they do not mind speculating, no matter how hopelessly, but they will not follow the natural laws of combustion simply because Nature takes out no patents and offers free salvation, and free salvation is not welcome. When there was a window tax people discovered the value of light. If there were an air tax, people who never open a window would begin to desire fresh air. If smoke is merely the result of neglect of known principles, and it is nothing else, then those who make it ought to pay for their preference.

German Electrical Imports and Exports.—The exportation of electrical machinery from Germany during the nine months ending with September last reached a total of 10,241 tons, as compared with only 9,857 tons in the corresponding period of last year. There has also been a slight increase in the imports of foreign electrical machinery into Germany—from 1,000 tons in the first nine months of 1904 to 1,100 tons in the nine months ending with September last.

REVIEWS.

The Electrical Transmission of Energy. By A. V. Abbott. New York: D. van Nostrand. London: Crosby Lockwood & Son. 1904. Price 30s. net.

Both in telegraphy and in the transmission of energy in bulk, the consideration of modern American methods is of the utmost value to engineers engaged in practice on this side of the water. We therefore welcome the re-issue of the above volume, which has been enlarged and brought up to date in order to cope with the evolution of the interurban railway, the increased use of extra high potential alternate current transmissions, and the gradual standardisation and modernisation of central station plant and the methods of running the same. In this country, a distinct cleavage between telegraph circuit work and the distribution of power has hitherto been made in the minds of engineers by the incidental fact that until recently the bulk of the telegraph and telephone wires were carried overhead, while central stations supplied their consumers by underground cables. Such artificial distinction, however, is now being removed; the modern tendency in telegraph and telephone work, at any rate, in crowded districts, is to bury the connections, while the introduction of tramway systems and the efforts being made by those interested in the supply of power in bulk are resulting in a more favourable attitude towards overhead circuits carrying currents at high voltages. The arrangement of Mr. Abbott's book, designed to systematise American practice, is therefore the best possible to meet the new conditions.

Starting with general remarks on systems of distribution, Mr. Abbott then discusses the properties of such wire as is used in transmission work, as copper, iron, aluminium and silicon-bronze. A brief description of the manufacture, testing and inspection of wire is followed by three chapters on the construction of aerial circuits, dealing respectively with general line work, including weak-current circuits, standard practice in electric railway circuits to date, and the protection of overhead circuits from breakdowns due to overloads and lightning. After two chapters on underground circuits, dealing with electric conduit systems (ancient and modern) and cables both for telegraph, telephone and power supply, a special chapter is devoted to the description of the third-rail system and the tramway or railway conduit.

All the above chapters are by way of analysis and description of methods: following these come sections on electrical instruments and methods of electrical measurements covering both D.C. and A.C. work. The usual enunciation of the problems of resistance, series and parallel circuits, Joule's law, &c., then follow, and to the properties of alternating current circuits are devoted 69 lucid pages.

Chapters 14 and 15 deal with the design of circuits for series and parallel distribution, taking economic conditions as regards first cost and expense of maintainence and operation into consideration, and setting forth the problems connected with the mechanical strength, heating limits and efficiency of conductors, &c. We note, by the way, that the five-wire system, though accounted by English engineers to be obsolete, is still given prominence in this chapter. Although the book essentially deals with transmission problems, the best location of the power station is incidentally dealt with in these sections.

Certain methods which cannot be conveniently classified under the above heads, such as feeding by motor-transformers, accumulators in distribution systems, and static transformers for supply systems, are dealt with in a separate chapter, while the last two sections of the book, those on polyphase transmission and the cost of production and distribution of electricity, are especially useful.

From the above *résumé* of the subjects dealt with in Mr. Abbott's book, it is seen that, given a satisfactory treatment of the subject matter, the work deserves to rank as standard. In our examination of the book we have not come across any serious errors, and the treatment of the subject is as simple as is consistent with an adequate presentment of knowledge. Mr. Abbott appears to be writing for the complete instruction of the man who is concerned in the development of a transmission system, and has little beyond good general and a little mathematical knowledge. Hence, although an appeal to

calculus is occasionally made, there is not the professorial mêlée of mathematics that one sometimes encounters in discussions on distribution. Moreover, the results, where of importance, are stated in the form of curves either incorporated in the text or placed on detached sheets, for which a pocket is provided in the cover of the book. The illustrations are numerous and useful; some, intended as horrible warnings, are most efficient in that respect. The "example of a direct-current line" facing p. 253, for instance, will never more, we hope, be seen outside of a nightmare. The book bears internal evidence of much practical research, and we can thoroughly recommend it to students and engineers who wish to specialise on transmission problems.

What do we know concerning Electricity? By Antonia Zimmern, B.Sc. London: Methuen & Co. 1905. Price 1s. 6d. net.

Antonia Zimmern has written a useful little work. A careful and thoughtful *résumé* is given of the fundamental phenomena from which the modern theories of electricity and magnetism are deduced. The book is primarily intended for non-technical readers. A clear account is given of the laws and principles of electricity, but the reader is not burdened with those details which, although necessary to the electrician in his everyday work, are not of absorbing interest to the general reader. Even the technical reader, however, will derive pleasure and instruction from a perusal of this little volume, as it is thoroughly up-to-date and clearly written. The chapters on the conduction of electricity through gases and on radio-activity may be mentioned as especially good.

Practical Electric Light Fitting. By F. C. Allsop. Sixth Edition. London: Whittaker and Co. 1905. Price 5s.

When a book has reached its sixth edition there is, perhaps, little to be said about it. Its popularity speaks for it. A technical book, however, is not like a novel; it needs repeated revision and modernising. This applies, perhaps, with greater force to books upon electrical practice than to any other kind of treatise. Whilst the author has succeeded fairly well in bringing the subject matter up to date, there is a strong savour of the manufacturer's descriptive catalogue about it. With few exceptions the illustrations are from trade blocks, and while, perhaps, none the worse for that, they stamp the book as lacking in originality.

In the chapter on arc lamps, a prominent place is given to the old-fashioned Brush lamp, this and the original Brockie-Pell being the only two lamps described. Not a word is said about enclosed lamps, flame lamps, or any of the other modern forms of lamp.

On the subject of jointing, the author is a trifle heterodox as regards the use of resin. He considers that it is almost impossible to make a good-soldered joint on a large cable, say, a 37/12, using resin only as a flux, and that if "spirits" be used, there need be no fear of any action on the wires if the joint is afterwards washed with ammonia and water. For a joint of this size, a melting-pot would, of course, be required, but, after all, soldered jointing, except in small conductors, is now very little needed. It is, in fact, prohibited generally, connection boxes being compulsory.

The illustrations of joints are somewhat antiquated. The author says that care must be taken not to nick the wire, but it would be impossible to cut the insulation to a square edge, as shown, without doing so. The insulation should be tapered, as mentioned by the author, not cut square as illustrated.

The chapter on "Private Installations" is badly in need of revision. It would pay the author best to rewrite it entirely. Engines which have almost reached the museum stage are spoken of as vertical high-speed engines; the horse-power is given in terms of nominal H.P. Lancashire boilers, we read, "are made usually to work at 80 lb. pressure, and from 4 to 40 H.P." For higher powers, "it is better to increase the number of boilers than make them larger than 40 H.P." Good gracious! where has the author been for the last 25 years or so. All the dynamos shown, some of which are termed "favourite" types, are of the old two-pole pattern.

Touching upon accumulators, the author tells us that the "Faure" type is "the most satisfactory and efficient"—rather an ungracious comment, seeing that a block—an ancient one—of the D.P. cell adorns the pages. The truth is, that only one of the many makers of repute still uses the Faure plate for both positive and negative. The latest practice is a Planté positive and pasted negative. We should be glad to see the accumulator which gives 2·25 volts on a closed circuit, even "just after charging." Has the author never heard of the use of an automatic switch in accumulator circuits? It would appear not, from the diagram and description of the charging arrangements.

The points we have criticised should certainly be revised and brought up to date in a future edition, and some of the blocks might with advantage be replaced with modern ones.

Generally speaking, the book is otherwise fairly accurate and readable, and covers the ground of house wiring and fitting in a popular and practical way.

Molecular Forces and Newtonian Laws. By Alex. Clark, M.A. Glasgow: W. and R. Holmes. 1905. Price 3s. 6d. net.

Mr. Clark strives to convince us that he has established the general principles of "Magnetism, Electricity and Chemical Affinity" on a sound basis, and this book is written to demonstrate his contention. In criticising the sweeping assertions he makes, we must remember that in the preface he disclaims infallibility and invites the reader to point out errors. The reviewer, however, has received the impression that the author is unfamiliar with the standard works on the subject, a knowledge of which is an essential preliminary to propounding new theories. Maxwell hesitated to attack the problem of terrestrial magnetism, and we think that it is extremely unlikely that anyone apparently unfamiliar with Gauss's life-long labours on the subject should yet arrive at the true solution by a happy guess. The author makes many assertions concerning the supposed erroneous notions of the community at large, but the reviewer is not prepared to accept these assertions. The supposed errors are not so rampant as the author thinks. If he read Gauss's "Intensitas Vis Magneticae Terrestris" he would find that his theory did not apply to the facts.

A few extracts will prove to readers of the Electrical Review that possibly it is the author's and not the ordinary electrician's ideas that want clearing up. P. 60. "From the foregoing conclusions it follows that there can be no magnetic repulsion. Such a force could neither be equal to, nor greater than, the force of attraction, for then a small magnetised needle between the poles of a magnet would either not move at all, or it would move away from the nearer pole of the magnet."

The lines of force round a magnet are supposed to be *ellipses* (p. 59). On page 82 we read, "If the common theory were correct—that an electric current proceeds from higher to lower potential, more work, or heat, would be available at one part of the circuit than another. But this is not the case."

"Positive and negative points are not different potentials, but only the elements of force" (p. 115). Notwithstanding what the author says on p. 82, he proves Ohm's law (p. 117) by analogy with the approximate law of *statical friction*, ohmic resistance apparently being the reciprocal of the coefficient of friction. On p. 212 the author says, "But all motion is due to force, and is therefore in the same direction. . . When a gun is fired, the recoil of the gun is exactly equal to the *vis viva* of the ball; and if undisturbed both would return to the same point and with the same energy." The latter half of the above sentence appears to us to be unmitigated rubbish. We are afraid that the author can attach no clear meaning to the words he uses. *Vis viva* was a term introduced by Leibnitz in the year 1695 to denote the product of the mass of a body and the square of its velocity, and this is the meaning scientists still give to it.

The above extracts could be multiplied twenty-fold and yet not exhaust the many remarkable sayings in this work.

NEW PATENTS APPLIED FOR.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

14,889A. "Improvements in the method of insulating electric wires or cables." P. Coridori. (Date applied for under Rule 5 of the Patents Rules, 1905, July 19th, 1905.) December 11th. (Complete.)

1,482A. "Improvements in or relating to electrical contact makers or distributors." P. W. Noble. (Date applied for under Rule 5 of the Patents Rule, 1905, January 25th, 1905.) December 13th.

25,684. "Improvement in electrical conduit fittings." W. W. Strode and H. F. Richens. December 11th.

25,687. "Improvements in conduits for electrical conductors, pipes and the like." J. H. Harradine, J. T. Biddle and L. W. Crosta. December 11th.

25,702. "Improvements in electrical resistances." J. H. Holmes. December 11th. (Complete.)

25,729. "An improved automatic earthing device and cut-out for the overhead conductors of electric railways." W. E. Thomson and C. B. Pinkerton. December 11th.

25,748. "Improved magnetic separator." W. Simpkin and J. B. Ballantine. December 11th.

25,749. "Improvements in automatic starters for vapour apparatus." M. von Recklinghausen. (Date applied for under Patents Act, 1901, December 13th, 1904, being date of application in United States.) December 11th. (Complete.)

25,759. "Improvements in or relating to protective devices or the frames or stators of electric machines." C. de Kando. December 11th. (Complete.)

25,768. "Improvements in means for insulating electric wires or cables." P. Coridori. December 11th. (Complete.)

25,771. "Improvements in electric transformer furnaces." O. Frick. December 11th.

25,802. "An improved electrical terminal attachment device." S. J. Murphy. December 12th.

25,811. "Improvements applicable to trolley standards for electric cars." J. Aldworth, L. W. Crosta and W. Boot. December 12th.

25,826. "Improvements in and relating to means for automatically connecting up the subscribers of telephone exchanges to each other." J. Peticky, I. Cizek and F. Suchanek. December 12th. (Complete.)

25,840. "A new or improved means for conducting electric currents." F. Blaschke. December 12th.

25,855. "Improvements in and relating to radiators for use with electricity, oil, gas or other heating agent." L. Betts and The Improved Electric Supplies Co., Ltd. December 12th.

25,858. "Improvements relating to rail bonds for electric railways." H. H. Lake. (The American Steel and Wire Co., United States.) December 12th. (Complete.)

25,866. "Improvements in or relating to electric telegraphy." E. Raymond-Barker. December 12th. (Complete.)

25,880. "Improvements in electricity meters for alternating currents." L. R. Lester and The Rochdale Electric Co., Ltd. December 12th.

25,893. "Improvements in mercury or other vapour electric lamps." J. Skwiesky. December 13th.

25,944. "Improvements in electric arc lamps." J. Tollerton. December 13th.

25,952. "An improved dynamo-electric generator." P. Rabbidge. December 13th.

26,032. "Improvements in or relating to electric ignition systems for internal combustion engines." J. J. H. Sturmey. (C. E. Duryea, United States.) December 14th. (Complete.)

26,046. "Improvements in or relating to electric clocks." C. Hubert. December 14th.

26,052. "Improvements in or relating to apparatus for storing and paying out lengths of conductors or wires connected to electric instruments or apparatus." R. F. J. S. Baron. December 14th. (Complete.)

26,066. "Improvements in coin-freed electricity meters." J. M. Tourtel. December 14th.

26,072. "Improvements in telegraphs for transmitting orders." Siemens and Halske Akt.-Ges. (Date applied for under Patents Act, 1901, December 14th, 1904, being date of application in Germany.) December 14th. (Complete.)

26,081. "Improvements in or relating to tremblers for induction coils." C. H. Bryant and F. L. M. Forster. December 14th.

26,086. "Improvements in arc lamps." H. M. Korting. December 14th.

26,089. "Improvements in and relating to alternating current dynamo-electric machines." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) December 14th.

26,090. "Improvements in and relating to dynamo-electric machines." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) December 14th.

26,091. "Improvements in and relating to alternating current dynamo-electric machines." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) December 14th.

26,092. "Improvements in and relating to alternating-current dynamo-electric machines." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) December 14th.

26,093. "Improvements in and relating to dynamo-electric machines." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) December 14th.

26,094. "Improvements in and relating to the alternating-current dynamo-electric machines." Allgemeine Elektricitats Gesellschaft. (Date applied for under Patents Act, 1901, December 15th, 1904, being date of application in Germany.) December 14th. (Complete.)

26,097. "An apparatus for centralised control of electric switches connected to alternating-current distributing networks." J. D. Spark. December 15th.

26,109. "Improvements in and relating to conductors for the electric lighting of miners' safety lamps." D. Thomas and W. Phillips. December 15th.

26,122. "Improvements in and relating to incandescent and other electric lamps." W. J. Fowler. December 15th.

26,144. "Improvements in and connected with fuses for electrical circuits." W. E. Richards. December 15th. (Complete.)

26,149. "An improved system of electrical distribution." R. McKenzie Palmer. (Date applied for under Patents Act, 1901, December 22nd, 1904, being date of application in United States.) December 15th. (Complete.)

26,162. "Improvements in couplings for electrical wires." H. Fairbrother. (J. G. Thomas, U.S.A.) December 15th.

26,182. "Intercommunication by means of telephones or other electric signalling apparatus over lines used as feeder cables, pilot wires or the like." December 15th. R. W. Klitz.

26,187. "Improvements in means for controlling the lights in railway carriages lighted by electricity or gas." J. Stone & Co., Ltd., and A. H. Darker. December 15th.

26,207. "Improvements in protective devices for use in the distribution of electricity by overhead wires for electric tramways and the like." J. Robson. December 16th.

26,219. "A spring improved raising and lowering electric light device." W. Vernum. December 16th.

26,223. "Improvements in or connected with electric tramways on the conduit system." J. H. Peddle. December 16th.

26,281. "Improvements in electro-magnets for alternating current circuit breakers and the like." M. B. Field and Ferranti, Ltd. December 16th.

PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., and at Liverpool, price, post free, 9d. (in stamps).

1904.

Electric Telegraphy. A. Muirhead. 11,668. May 20th.

Central Exchange Telephone System. B. Brander. (Date applied for under Patents Rule 9, July 20th, 1904.) 16,038A.

Control of Electrically-Propelled Vehicles. J. S. Raworth. 17,975. August 18th.

Transformation of Repulsion Motors, when Running at Speed, into Rotating Field Synchronous Motors. H. Latour. (Date applied for under International Convention, August 27th, 1903.) 18,105. August 20th.

Arc Lamps. J. D. F. Andrews. 18,163. August 22nd.

Means for Controlling Electric Power Distributing Systems. J. L. Routin. 18,185. August 22nd.

Control of Alternating Current Electric Motors. British Thomson-Houston Co., Ltd. (General Electric Co.) 18,683. August 29th.

Apparatus for Indicating and Recording Electrically at a Distance the Movements of Instruments Indicating Physical Conditions. J. F. Le Page. (Post dated September 30th, 1904.) 18,790. August 31st.

Electric Capstans. W. Dixon. 20,314. September 21st.

Apparatus Adapted for Indicating or Automatically Controlling or Varying the Flow of Electric Current. G. C. Fricker. 20,554. September 28th.

Connection of Electric or other Wires. W. J. Ford and S. Sudworth. 21,872. September 28th.

Single-Phase Dynamo-Electric Machines. E. A. Carolan. (General Electric Co.) 21,045. September 30th.

Method of Effecting Communication between Telephone Exchanges and Apparatus therefor. A. T. M. Thomson. 21,401. October 5th.

Electrical Switches. H. Nunns. 21,422. October 6th.

Electric Switches. British Thomson-Houston Co., Ltd. (General Electric Co.) 22,744. October 21st.

Variable Speed Windings for Alternating Current Motors. British Thomson-Houston Co., Ltd. (General Electric Co.) 22,820. October 22nd.

Alternating Current Electric Motors. British Thomson-Houston Co., Ltd. (General Electric Co.) 22,822. October 22nd.

Application of a Coherer to any Electric Transmission by Means of Conductors for any Distance, for Telegraphic, Telephonic, Signalling Bell, or other Systems. G. Magini. 25,191. November 19th.

Method of Amplifying Variations of Energy in Electric Circuits. P. C. Hewitt. 25,406. November 22nd.

1905.

Construction of Electric Belts, Bands, or other Wearing Devices. J. W. Fowler. 2,777. February 10th.

Electrostatic Watt and Watt-Hour Meters. E. Wilson and W. H. Wilson. 2,850. February 11th.

Automatic Regulating Apparatus for Electrical Installations with Variable Current Consumption, Worked by Dynamos and Accumulator Batteries. E. Dick. 3,183. February 15th.

Prepayment Attachments for Electricity Meters. H. J. J. Swain. 3,604. February 21st.

Automatic Electric Warning Signals for Railways and the like. J. H. Hollyer. 4,127. February 28th.

Electric Ignition Devices for Internal Combustion Engines. F. Millington and A. H. Miller. 4,233. March 1st.

Supply and Regulation of the Electric Energy Employed in the Operation of Arc Lamps Used in Search Lights and like Apparatus. British Thomson-Houston Co., Ltd. (General Electric Co.) 4,379. March 2nd.

Towers or Standards for Supporting Electric Lamps. S. T. Coverstone. 4,774. March 7th.

Arc Lamps. P. M. Justice. (Phönix Elektrotechnische G.m.b.H.) 4,848. March 8th.

Trolleys for Electric Tramcars and the like. J. W. Bradley and J. F. Mason. 5,205. March 13th.

Safety Electric Circuit Closers. L. Ottinger. 7,008. April 3rd.

Apparatus for the Measurement of X Rays and other Similar Radiations. G. E. Gaiffe. 7,620. April 10th.

Appliances for Lighting Gas Lamps and the like by Electricity. W. P. Thompson. (O. Freudenthal.) 7,814. April 12th.

Night Sights with Electric Incandescent Lamps for Artillery Sighting or for any Instrument in which Night Sighting may be Required. G. A. Bertalot. (Bonino.) 10,480. May 18th.

Telautograph Apparatus. L. J. Breuer and G. Isaac. (Date applied for under International Convention, May 25th, 1904.) 10,978. May 25th.

Commutators of Dynamo-Electric Machines. Siemens Bros. & Co., Ltd., and Berry. 13,588. July 1st.

Method of and Apparatus for Cooling Commutators of Dynamo-Electric Machines. Siemens Bros. & Co., Ltd., and H. Berry. 13,589. July 1st.

Transportable Telephone Apparatus. N. Jacobsen. (Date applied for under International Convention, December 16th, 1904.) 15,290. July 25th.

Telephone or like Transmitters. H. A. Cutmore and Telaupad Syndicate, Ltd. 17,302. August 26th.

Trolley Heads for Overhead System of Electrical Traction. J. A. Orme. 860. January 16th.

Conduits for the Protection of Electrical Conductors. D. Maxwell. 1,247. January 23rd.

Electric Accumulators or Secondary Batteries. Vickers, Sons and Maxim, Ltd., and R. F. Hall. 2,022. February 1st.

Rectifiers for Alternating Electric Currents. O. de Faria. (Date applied for under International Convention, February 20th, 1904.) 2,944. February 13th.

Electric Motor Meters and other Measuring Instruments more Especially Designed for Reducing the Effects of Friction in such Instruments. A. G. Davis and C. D. Haskins. 5,369. March 14th.

Telephone Calls. P. T. Geyerman. 5,577. March 16th.

Electricity Meters. J. Busch and H. Roosen. 6,640. March 29th.

Electricity Meters. J. Busch and H. Roosen. (Date applied for under Patents Rule 9, March 29th, 1905.) 6,640A. March 29th.

Telephone Apparatus. E. Ehrlich. 7,159. April 5th.

Air-Insulated Telephone and Telegraph Cables. E. Jensen and H. Schumacher Aktieselskab. (Date applied for under International Convention, April 9th.) 7,498. April 8th.

Electric Switches. W. F. Jones, D. G. Macmillan and G. J. Neybergh. (Date applied for under International Convention, January 12th, 1905.) 8,615. April 22nd.

Fireproof Casings and Covers for Electric Conductors. H. R. Romney. 9,439. May 4th.

Treating of Patients by Static, Galvanic, or like Electrical Currents. G. J. Macaura. 10,067. May 13th.

Insulating Base for Electric Switches, Plugs, Pushes, and the like. General Contracts Co., Ltd., and J. G. Salamon. 10,112. May 13th.

"ELECTRICAL REVIEW" LIST OF ELECTR

	Place.	Supply Authority.	Year of opening	Engineer.	Pressure of supply, volts.	Frequency and Phase.	Boilers and Auxiliaries.	Engines.	Generators.	Total Capacity in KW.
PROVINCIAL										
191	LLANDILO	Urban District Council	1902	W. J. Maybery	230	Direct	1 Cornish, 1 Lanc.	1 Browett-Lindley, 1 Howden	2 Bertram Thomas	120
192	LLANDRINDOD WELLS	Llandrindod Wells E. L. & P. Co.	1897	J. Brown	230 & 460	Direct	3 Lanc.	1 Willans, 1 Alley & MacLellan, 1 Beavell	1 Siemens, 1 Mather & Platt, 1 Bertram Thomas	230
193	LLANDUDNO	Urban District Council	1898	H. Morton	220 & 440	Direct	6 B. & W. (2 with 4-cell Beaman & Deas destructor), econ.	3 Belliss, 3 Allen	4 Silvertown, 2 Crompton	700
194	LONDONDERRY	Corporation	1894	R. V. Macrory	220 & 440 arc. lg. 2,500	Direct	5 Lanc.	3 Brown & Sons, 4 Allen	6 Siemens arc, 4 B. T.-H.	880
195	LONG EATON	Urban District Council	1903	F. Worrall	220	Direct	3 Lanc.	3 Browett-Lindley	5 Lanc. D. & M. Co.	450
196	LONGTON	Corporation	1901	W. Langford	230	Direct	2 B & W., econ.	2 Belliss	2 E. C. C.	300
197	LOUGHBOROUGH	Corporation	1904	W. H. Allen	220 & 440	Direct	2 Danks marine dryback	2 Brush-Parsons turbines	2 Brush	500
198	LOWESTOFT	Corporation	1901	G. A. Bruce	230 & 460	Direct	4 B. & W., suphtrs., cond., 1 Musgrave, Horsfall 4-cell destructor	2 Musgrave, 2 Browett-Lindley, 1 Willans	4 B. T.-H., 1 Lanc. D. & M. Co.	1,475
199	LUTON	Corporation	1901	W. H. Cooke	250 & 500	Direct	2 Lanc., cond., econ., suphtr., water softener	4 Allen	5 Allen	297
200	LYMINGTON	Lymington El. Light & Power Co.	1900	Glynn Salter	240	Direct	2 B. & W., suphtrs.	2 Belliss	2 Parker	124
201	LYNTON & LYNMOUTH	Lynton & Lynmouth El. Light Co.	1890	P. T. Kimmins	100	100~, 1-ph.	1 loco.	1 Sherman (steam), 1 Escher Wyss, 3 Hett (water)	2 Brush, 1 E. C. C.	150
202	MACROOM	Macroom & District El. Ltg. Synd.	1899	D. E. McDonnell	230	100~, 1-ph.	1 Cornish	1 water turbine, 1 water wheel, 1 Brush	1 B. T.-H., 1 Brush, 1 Ediswan	150
203	MAIDSTONE	Corporation	1901	E. E. Hoadley	220 & 460	Direct	4 Paxman dryback	5 Peache	3 Parker, 2 Westinghouse	750
204	MALTON	Northern Counties Elec. Supply Co.	1904	J. Chandler*	230 & 460	Direct	Gas	2 Crossley gas engines	4 Bruce Peebles	80
205	MALVERN	Urban District Council	1904	W. J. R. Baker	100 & 200	50~, 1-ph.	2 Lanc., Wilton furnaces, used as destructors	2 Belliss	2 Dick Kerr	200
206	MANCHESTER	Corporation	1898	S. L. Pearce	100, 200, & 400 D.C. 6,500 A.C.	Direct Direct 50~, 3-ph. 6,500 volts	*Dickinson Street*:—18 Lanc., 4 B. & W., stokers, cond., econ. *Bloom Street*:—11 B. & W., stokers, cond., econ. *Stuart Street*:—36 B. & W., stokers, cond., clg. trs., econ.	4 Goodfellow, 2 Musgrave, 2 Ferranti, 4 Parsons turbines 4 Musgrave 6 Yates & Thom, 2 Wallsend Slipway, 3 Willans	5 E. C. C., 3 Siemens, 2 Westinghouse, 2 Parsons 4 Westinghouse 11 Electrical Co. (A. E. G.)	10,600 7,200 16,500
207	MANSFIELD	Corporation	1903	E. Holcombe Hewlett	240 & 480 550-600 tr.	Direct	3 Lanc., 2 B. & W., econ., stokers, cond., forced draught, Heenan 6-cell destr.	3 Alley & MacLellan	3 Parker	720
208	MARCATE & BROADSTAIRS	Isle of Thanet El. Tram. & Ltg. Co.	1903	R. Humphries	240 & 480	Direct	4 B. & W.	2 Allis, 2 Belliss	B.T.-H., 2 3-ph., 2 D.C.	1,000
209	MARKET DRAYTON	Market Drayton Elec. Lt. & Pr. Co.	1903	C. F. Bottomley	240 & 480	Direct	2 Davey Paxman loco., Boby heater	2 Belliss	2 Parker	90
210	MELROSE BURCH	Electric Supply Corporation	1904		225 & 450	Direct	2 Crossley (pressure) gas producers	2 Crossley	2 Crompton	66
211	MELTON MOWBRAY	Melton Mowbray Electric Light Co.	1900	W. H. Russell	240 & 480	Direct	3 B. & W., suphtrs., stokers, econ., cond.	3 Parsons turbines	3 Parsons	300
212	MERTHYR TYDFIL	Merthyr Elec. Traction and Lg. Co.	1901	A. J. L. Plunket	230 & 460	Direct	4 B. & W., cond.	4 Browett-Lindley	3 Peebles, 1 Silvertown	680
213	MEVAGISSEY	Mevagissey Electric Light Co.	1896	J. A. Hill	110	Direct	1 Paxman loco.	1 Paxman	1 Crompton	26
214	MEXBOROUGH	Urban District Council	1902	H. M. Taylor	220 & 440	Direct	3 Lanc., Meldrum 3 cell dest.	2 Willans, 1 Belliss	3 Mavor & Coulson	300
215	MIDDLESBROUGH	Corporation	1901	John Senior	220 & 440	Direct	6 Lanc., stokers and econ.	1 Davy Bros., 3 Browett Lindley, 1 Brush-Parsons turbine	2 Jackson, 2 Witting, 1 Brush	1,600
216	MIDDLETON	Corporation	1902	S. Pauls	220 & 440	Direct	3 Lanc, suphtrs., cond. (Meldrum 2-cell dest. being constructed).	3 Belliss	3 Siemens	768
217	MINEHEAD	Minehead Electric Supply Co.	1903	Charles Mounsey	220	Direct		2 Hornsby-Akroyd crude oil engines	2 Birkett	32
218	MONMOUTH	Corporation	1899	A. W. Blake	100 & 200	60~, 1-ph.	1 Cornish, 1 Paxman loco. and water power	4 Ransome	4 Siemens	128
219	MONTROSE	North of Scotland E. L. & P. Co.	1901	Harold Hale	240 & 480	Direct	3 B. & W., superheaters	3 Belliss	3 Parker	282
220	MORECAMBE	Corporation	1898	W. H. Hall	220	Direct	2 Lanc., 2 B. & W.	5 Peache, 2 Parsons turbines	5 Parker, 2 Parsons	700
221	MORLEY	Corporation	1898	J. E. Ellis	100 & 200	60~, 1-ph.	3 Lanc., stokers and econ.	2 Pollitt & Wigzell, 1 Belliss	2 E. C. C., 1 Fowler	228
222	MORPETH	Northern Counties Elec. Supply Co.	1904	W. H. Bibby (Res.)	230 & 460	Direct	1 Ruston Proctor	1 Scott & Mountain	1 Scott & Mountain	65
223	MOTHERWELL	Corporation	1901	S. Williams	230 & 460	Direct	3 Lanc., 1 B. & W., feed htr.	7 Willans	4 Mavor & Coulson, 2 Lanc. D. & M. Co., 1 Siemens	1,410
224	MUSSELBURGH	Nation l Electric Construction Co.	1904	William Bain	230 & 460 lg. 500 tr.	Direct	3 Heenan & Froude water tube	3 Davey Paxman	3 Lanc D. & M. Co.	450
225	NELSON	Corporation	1892	W. Allan Fraser	230 & 460	Direct	2 Lanc., stokers, econ., Meldrum 4-cell dest.	4 Willans	4 Bruce Peebles	1,000
226	NEWBURY	Urban Electric Supply Co.	1905	H. W. Bush	240 & 480	Direct	Dowson gas plant	1 Campbell gas engine, 1 25-H.P. water wheel, 2 Dell water turbines	Parker, 1 water driven booster balancer, 1 generator	145
227	NEWCASTLE-ON-TYNE	Newcastle & Dist. Elec. Lighting Co.	1890	W. D. Hunter	100 A.C.; 240 & 480 D.C.	80~, 1-ph., and direct	11 Lanc., econ. for six, 5 Stirling	15 Parsons turbines	15 Parsons	6,500
228	NEWCASTLE-ON-TYNE AND TYNESIDE	Newcastle-on-Tyne Electric Supply Co.	1890	R. P. Sloan (Man.)	240 & 480 D.C., 440 A.C.	40~, 3-ph., and direct	8 B. & W., 10 B. & W. marine type, ch. grate stokers, cond.	3 Wigham Richardson, 1 Wallsend Slipway; 1 Brown Boveri-Parsons turbine, 4 Parsons turbines	4 B T.-H., 1 Brown-Boveri, 4 Parsons	16,250
229	NEWCASTLE-UNDER-LYME	Corporation	1904	J. F. Shoolbred	230	Direct		2 Andrews gas engines	2 Electric Construction Co.	60
230	NEWMARKET	Newmarket Electric Light Co.	1899	F. A. Simpson	210	Direct	4 Paxman (2 loco., 2 Economic)	2 Willans, 1 Allen, 1 Belliss	3 Parker, 1 Allen	350
231	NEWPORT & COWES	Isle of Wight El. Lt. & Pr. Co.	1901 and 1903	A. E. Mayes (Eng. & Man.) F. T. Crowe (Res. Eng.) H. Collings Bishop	240 & 480	Direct	2 B. & W., 1 Sugden, mech. stokers, suphtrs., feed heater	3 Belliss	4 Parker	390
232	NEWPORT (MON.)	Corporation	1895		100 & 200	87.5~, 1-ph.	8 Lanc., stokers, cond., econ.	4 Uskside Eng. Co., 1 Brush, 3 Fowler, 1 Belliss	1 Mordey, 7 Hall (Fowler), 1 Siemens	1,050
233	NEWTON ABBOTT	Urban Electric Supply Co.	1902	F. C. Pay	240 & 480	Direct	2 B. & W., suphtrs.	2 Belliss	2 Parker	180
234	NORTHALLERTON	Northallerton Elec. Lt. & Power Co.	1899	F. R. Batty	220	Direct	1 Paxman Economic, 1 Galloway	1 Alley & MacLellan, 1 Willans	1 G.E.Co., 1 E.C.C.	150
235	NORTHAMPTON	Northampton Elec. Lt. & Power Co.	1891	G. H. Jackson	210 & 420	Direct	2 Lanc., 2 B. & W., stokers, econ., suphtrs.	5 Willans	5 Crompton	1,140
236	NORTHWICH	Northwich Electric Supply Co.	1897	W. Boyd	220 & 440	Direct		4 Crossley gas engines*	5 Laurence-Scott, 1 Mather & Platt	245
237	NORWICH	Corporation	1898	F. M. Lo[illegible]	220 & 440	Direct	7 B. & W., 4 dryback, econ.	6 Willans, 1 Parsons turbine	3 Laurence-Scott, 3 Siemens	2,834
238	NOTTINGHAM	Corporation	1894	H. Talbot	200 & 400	Direct	16 Lanc., 14 dryback, econ., feed. htr., 6 B. & W. with 12-cell Manlove dest.	32 Willans	32 Siemens	8,723
239	NUNEATON	Urban District Council	1900	S. C. Gibson	220 & 440	Direct	3 B. & W., economiser, cond.	2 Willans, 1 Paxman	1 Johnson & Phillips, 1 Siemens, 1 E.C.C.	375
240	OGMORE VALLEY	Ogmore Valley E. L. & P. Supply Co.	1891	T. Thomas	100 to 220	40~, 1-ph., & direct	2 B. & W.	1 Robey, 2 Paxman	2 Parker, D.C.; 2 Siemens A.C.	150
241	OLDHAM	Corporation	1894	S. W. Newington	210 & 420	Direct	8 Lanc., 8 Marine, 3 Climax, cond., 8 destructor cells	16 Willans, 1 Parsons turbine	4 Hall, 12 Siemens, 1 Parsons	5,232
242	OSWESTRY	Oswestry Elec. Light & Power Co.	1893	E. B. Smith	220	Direct	2 loco., 2 B. & W., ch. gr. stoker	2 Marshall, 2 Belliss, 1 Scott & Mountain	2 Parker, 1 Siemens, 1 Scott & Mountain, 1 McClure	253
243	OULTON BROAD	Oulton Broad Electricity Co.	1902	B. Barber	230	Direct	1 loco., 1 Cornish	1 Paxman, 1 Hornsby	1 Laurence Scott, 1 Harrison Engineering Co.	34
244	OXFORD	Oxford Electric Co.	1892	F. H. Francis	100	Direct	5 loco., 2 Economic; cond.	5 McLaren, 1 Willans, 1 Belliss	7 Electric Construction Co.	1,200
245	PAISLEY	Corporation	1899	C. F. Parkinson	200 A.C. 500 D.C. (tr.)	50~, 1-ph. & direct	8 B. & W., stokers	1 Adamson, 2 Ferranti, 2 Peache, 2 Davey Paxman	2 Ferranti, 2 Schuckert, A.C.; 1 Schuckert, 2 Bruce Peebles, D.C.	1,200 (lg.) 1,800 (tr.)
246	PARTICK	Corporation	1902	H. B. Maxwell	240 & 480	Direct	4 B. & W., 1 Stirling, econ., Manlove Alliott 6-cell dest.	5 Belliss	4 Peebles, 2 Greenwood & Batley	1,050
247	PEMBERTON	Urban District Council	1902	J. Slevin	230 & 460	Direct	3 Lanc., cond., clg. tr.	4 Belliss	2 Mather & Platt, 2 Dick Kerr	1,000
248	PEMBROKE (DUBLIN)	Urban District Council	1900	S. L. R. Price	230 & 440	Direct	3 Lanc., 1 B. & W., stokers, econ., cond.	2 Easton	4 Easton	300
249	PENARTH	Penarth Electric Lighting Co.	1901	S. G. Leech	230 & 460	Direct	2 B. & W., feed htr.	2 Brush Universal	2 Brush	100
250	PERTH	Corporation	1901	J. Lambert	230 & 460	Direct	4 B. & W., cond., econ.	4 Willans, 1 Brush	3 Peebles, 2 Brit. Elec. Plant Co.	1,175
251	PETERBOROUGH	Corporation	1900	J. C. Gill	200 & 400	Direct	4 Lanc., cond., econ.	5 Willans, 1 Belliss	2 G.E.Co., 1 Peebles, 3 Crompton	840
252	PLYMOUTH	Corporation	1899	E. G. Okell	100 & 200	50~, 1-ph., D.C. for tr.	9 Lanc., stokers, econ., cond.	5 Belliss, 2 Ferranti	6 Ferranti, 3 Westinghouse	2,300
253	PONTYPOOL	Pontypool Elec. Light & Power Co.	1893		108	Direct	3 loco., feed htr.	4 Willans	3 Crompton, 1 Parker	109
254	PONTYPRIDD	Urban District Council	1904	J. E. Teasdel	220 & 440	Direct	3 B. & W., econ., Heenan 3-cell dest.	3 Combe-Barbour	3 Greenwood & Batley	600
255	PORTSMOUTH	Corporation	1894	W. S. Foale	100	50~, 1-ph.	18 Lanc., stokers, econ., cond.	5 Yates & Thom, 3 Parsons turbines	4 Ferranti, 1 Brown-Boveri, 3 Parsons	3,386
256	PRESCOT DISTRICT	British Insulated & Helsby Cables	1891	R. P. Nash	100 A.C., 250 & 550 D.C.	100~, 1 ph. & direct	5 Lanc., stokers, suphtrs., econ., cond., clg. tr.	3 Browett-Lindley, 1 Alley and MacLellan, 1 Ferranti, 1 Willans	1 English Electric, 1 Peebles, 1 Silvertown, 3 Johnson & Phillips	1,460
257	PRESTON	National Electric Supply Co.	1892	J. H. Tonge	250	50~, 1-ph., & direct	6 Lanc., 3 dryback	5 Belliss, 3 Willans	2 Clark-Muirhead, 2 Siemens, 2 E.C.C. direct, 2 E.C.C. alt g.	1,970
258	QUEENSTOWN	Cork Elec. Trwys. and Lighting Co.	1900	W. H. Joyce	230 & 460	Direct	2 B. & W.	2 Belliss	2 B.T.H.	100
259	RADCLIFFE	Urban District Council	1904	M. B. Henry	220	Direct	2 Lanc.	2 Browett-Lindley	3 Mather & Platt	240
260	RAMSGATE	Ramsgate & Dist. Elec. Supply Co.	1905	M. Farrer	240 & 480	Direct	2 Hornsby	2 Belliss	2 Parker	250
261	RATHMINES	Urban District Council	1900	G. F. Pilditch	220 & 440	Direct	3 Lanc., stokers, econ., Heenan & Froude 6-cell dest.	3 Willans	4 Mather & Platt, 2 Dick Kerr	750
262	READING	Reading Electric Supply Co.	1895	A. T. Cooper	200 A.C., 200 & 400 D.C.	67~, 1-ph. & direct	4 Lanc., 2 B. & W., econ., suphtrs.	3 Fowler, 5 Belliss, 2 Willans (gas)	3 Fowler, A.C., 8 E.C.C. and 5 Siemens D.C.	2,675
263	REDDITCH	Urban District Council	1899	W. J. Ferguson	200	66~, 1-ph.	Dowson gas plant	3 Premier, 1 Willans, gas engines	3 Johnson & Phillips, 1 E.C.C.	435
264	REIGATE	Corporation	1901	W. S. Ross	200	50~, 1-ph.	2 B. & W., suphtrs., econ., detartariser	3 Allen	3 E.C.C.	280
265	RHYL	Urban District Council	1901	E. H. Wright	220	Direct	4 B. & W.	3 Alley and MacLellan	3 Lancashire D. & M. Co.	495
266	RICHMOND (SURREY)	Richmond (Surrey) E. L. & P. Co.	1893	L. P. Greig	110 & 220	Direct	3 Paxman dryback, 3 Paxman Economic	2 Paul, 2 Brush, 3 Belliss	2 Clark-Muirhead, 2 Brush, 3 Westinghouse	1,150
267	ROCHDALE	Corporation	1900	C. C. Atchison	220 & 440 D.C. 3,000 A.C.	50~, 3-ph., & direct	5 Lanc., stokers, cond., econ.	5 Belliss, 2 Browett-Lindley	1 E.C.C., 2 Siemens, 2 Johnson-Lundell, D.C.; 2 B.T H., A.C.	1,976
268	ROSS	Ross Electric Light and Power Co.	1902	A. P. Lumsden	230	Direct	2 Marshall loco-type	2 Tangye	2 Silvertown	80
269	ROTHERHAM	Corporation	1901	Edward Cross	230 & 460	Direct	7 Lancashire	8 Allen	7 Allen, 1 Siemens	1,208
270	ROTHESAY	Corporation	1899	E. B. Stiven	230 & 460	Direct	2 Lancashire	2 Alley & MacLellan	2 Parker	84
271	ROTTINGDEAN	New Rottingdean Electricity Co.	1895	A. Jupp	100	Direct	1 Paxman	1 Browett-Lindley, 1 Belliss	1 Flather, 1 Silvertown	43
272	ROUNDHAY	Roundhay & Dist. Elec. Light Co.	1903	H. Love	230 & 460	Direct	Gas plant	2 Campbell gas engines	2 Greenwood & Batley	120
273	RUGBY	Urban District Council	1900	T. S. Shenton	220	50~, 3-ph.		2 Willans	2 B.T.H.	210
274	RUGBY SCHOOL	Rugby School Electric Light Co.	1896	A. E. Lee	100	100~, 1-ph.	Dowson gas plant, 1 vertical boiler	2 Crossley (gas)	2 Brush	85
275	RYDE & ST. HELENS	Isle of Wight Elec. Lt. & Pr. Co.	1903	A. E. Mayes (Eng. & Man.)	240 & 480	Direct, & 50~, 1-ph.	2 Tangye gas producers, w. vert. boilers, clg. tr.	3 3-cyl. Tangye, vert. Beavell compr. for starting	2 Parker	192
276	ST. ANNES-ON-SEA	Urban District Council	1901	J. H. Clothier	240	Direct	4 Dryback	5 Willans	2 Parker, 3 Dick Kerr	750
277	ST. AUSTELL	St. Austell & Dist. El. Lt. & Pr. Co.	1897	A. B. Child	110 & 220	Direct	2 Dowson suction gas producers	2 Premier gas	4 Mackie	80
278	ST. HELENS	Corporation	1898	R.M. Hollingsworth	230	Direct	4 Lanc., 4 B. & W., cond., econ., Beaman & Deas 4-cell destructor	9 Willans	4 Mather & Platt, 2 Dick Kerr	1,240
279	SALE	Urban District Council	1906	C. J. Wood	200 & 460	Direct	Energy supplied in bulk by Trafford Power & Light Co., at 3,000 v., 3-ph., 50~.		4 British Schuckert Motor Generators	160
280	SALFORD	Corporation	1896	C. D. Tabe	230, 440 D.C., 200 A.C.	75~, 1-ph., & direct	16 Lanc., stokers, cond., econ.	8 Browett-Lindley, 1 Mather & Platt	9 Mather & Platt	6,020
281	SALISBURY	Salisbury Elec. Light & Supply Co.	1906	A. B. Randall	210	Direct	4 B. & W., suphtrs., ch. gr. stokers, cond.	4 Belliss, 1 Gilkes turbine (water)	4 Parker, 1 Parker generator-balancer and boosters—4 machines	600

PART II.

CTRICITY SUPPLY WORKS OF THE UNITED

	Total Capacity in KW.	Max. load recorded in KW.	Storage Battery.	Mains.	Total capital expended.	Private lighting, eqvt. 8 c.p. lamps.	Public lighting.	No. and H.P. of private motors.	No. and H.P. of traction motors.	Total connections of all kinds, eqvt. 8 c.p. lamps.	Percentage increase during year.	Price charged per unit, pence.	System of charging.	Units sold during last complete year.	PRI Av. price obtained
..	120	39	Tudor, max. dis. 23 KW. ..	Glover, lead covd. and armd. direct	£7,000	..	96 inc. ..	..	..	..	..	Lg. 6, pb. lg. 3, pr. 3 ..	Flat rate ..	..	..
att, 1	230	..	Tudor	Glover conc. and single, B.I. & Helsby 2-core, armd. direct	..	..	..	..	..	..	..	Lg. 6, pr. 6 to 2½	Flat rate and scale	120,000	..
..	700	460	Hart, max. dis. 36 KW. ..	Henley, Glover, and B. I. & H., triple conc. fdrs., 3-core dist. armd., lead covd., direct	£39,977	24,711	48 arc, 8 inc.	24=86 H.P.	..	27,595	8.6	Lg. 7 & 3½, or 5½, pr. 2, pb. lg. 1.5	Max. dem., flat & contract	360,111	4.25
..	880	236	E. P. S., max. dis. 670 KW. ..	Western Electric, paper, lead covd., conc., fdrs. in ducts, dist. solid	£48,436	6,987	186 arc .. 15 double inc.	24=112 H.P.	..	15,850	..	Lg. 6 & 2, pr. 2 to 1½, pb. lg. £18.9 arc, £2.925 inc.	Max. demand & flat rate	334,017	3.25
..	450	242	.. ..	B.I. & H., lead covd., fdrs. triple conc., solid; dist., triple conc., armd. direct	£20,454	9,672	2 arc., 174 inc., 65 Nernst	45=103 H.P.	..	16,194	45	Lg. 4, pr. 2½ to 1, pb. lg. 2	Flat rate & scale	335,636	2.35
..	300	69	Chloride, 160 KW.	Callender, vulc. bitumen, solid	£51,346	5,519	..	34 H.P. ..	..	6,462	20	Lg. 8 & 2, pr. 2½, pr. 1½ ..	Max. demand & flat rate	72,885	4.2
..	500	147	Pritchetts & Gold, max dis. 65 KW.	Henley, paper, lead covd., 3-core dist., conc. feeders ..	£26,000	..	..	9=91 H P...	..	5,160	..	Lg. 5, pb. lg. 2½, pr. 1½—2½	Flat rate and sliding scale	..	..
..	1,475	550	.. ..	Callender and St. Helens, fdrs. armd. direct, dist. v. bit. solid	£65,000	25,424	72 arc, 291 inc. 38 Nernst.	4=160 H.P.	40=1,000 H.P.	58,372	..	Lg. 5½, pr. 2½, pb. lg. 3, tr. 2½	Flat rate and contract	793,106	3.37
..	297	285	Chloride, max. dis. 120 KW...	Callender, v. bit. 3-core dist.; fdrs. conc. & single St. Helens Dialite	£32,607	14,032	10 arc, 34 inc. 3 Nernst	76=823 H.P.	..	23,555	53	Lg. 6 & 3, or 4½, pr. 2, 1½ & 1½, pb. lg. 3	Max. dem., flat rate & scale	274,521	3.2
..	124	77.5	D. P., max. dis. 22 KW. ..	Callender, triple conc. fdrs., 3-core dist., all armd. ..	£33,328	10,400	2 arc, 64 inc., 45 Nernst.	15=55½ H.P.	..	11,950	43	Lg. 7 & 4, or 6, pr. 4 & 1½, or 2½, pb. lg. £2.75 p.a.	Max. demand & flat rate	88,974	4.84
..	150	67	.. ..	Glover and Callender, ppr., fdrs. 2-core, dist. single ..	£8,000	2,974	1 arc, 86 inc.	..	..	3,240	22	Lg. 5, pb. lg. £3 p.a. ..	Flat rate & contract	100,378	..
..	150	47	.. ..	Glover conc. lead covd. and armd...	..	2,009	87 inc. ..	..	..	2,527	..	Lg. 4½, or ls. per c.p.p.a., pb. lg. contract	Flat rate & contract	..	..
..	750	351	Chloride, max. dis. 150 KW.	Callender, single, solid in iron trough	£50,000	20,000	46 arc, 180 Nernst	235 H.P. ..	..	27,180	..	Lg. 7 & 2", pb. lg. 1.75, tr. 2 to 1½, pr. 2 to 1	Max. demand, flat, & scale	493,400	3.26
..	80	37.5	Chloride, max. dis. 75 KW...	Callender	..	..	..	5=23½ H.P.	..	..	..	Lg. 5½ to 4, pr. 2½ to 1½..	Sliding scale	..	..
..	200	40	.. ..	Glover, Diatrine, conc., lead covd. and armd., direct..	£17,000	3,469	..	4=2½ H.P....	..	3,552	112	Lg. 6 & 4", pr. 3	Special scale & flat rate	35,097	5.108
ing-	10,600														
..	7,200	18,745	Chloride, 480 KW.-hrs. ..	Bare copper, paper, v. bit., Callender, B.I. & H., Glover, Western Electric, and Johnson & Phillips	£2,190,690	458,442	58 arc ..	1,917=9,395 H.P.	*	735,382	21	Lg. 5½ & 1½, pr. 1½—1, pb. lg. 2, tr. 1.49	Max. demand & sliding scale	38,686,710	2.14
..	16,500														
..	720	150	Tudor, max. dis. 100 KW. ..	Western Electric, triple conc. ppr. lead covd., laid solid in c'ware and iron trough	£65,000	8,760	40 arc, 12 Nernst	33=83 H.P.	..	12,250	29	Lg. 7 & 1, pr. 4 & 1, pb. lg. 2	Max. demand & 2-rate mtr.	194,000*	3.7*
..	1,000	150 (ex. tr.)	Tudor, max. dis. 25 KW. ..	Callender, triple conc.	..	10,000	20 arc ..	..	120=3,000 H.P.	..	..	Lg. 5, pr. 3, pb. lg. 2½ ..	Flat rate & sl. scale	..	4
..	90	54	Pritchetts, 400 amp.-hrs. ..	Callender, fdrs. triple conc. bit. fibre, ld. covd. armd.; dist. 3-core lead covd. and armd., direct	£14,698	5,376	..	20=73 H.P.	..	7,575	..	Lg. 7 & 4., pr. 2½ ..	Max. demand & flat rate	40,998	4.9
..	66	..	A. B. P., max. dis. 70 KW. ..	Callender, bitumen, single laid solid	..	..	..	..	..	1,036*	..	Lg. 6, pb. lg. & pr. 3 ..	Sliding scale	..	..
..	300	118.5	D. P., max. dis. 120 KW. ..	Callender, lead covd. steel taped, triple conc. fdrs., 3-core dist.	£37,673	9,824	8 arc, 126 inc., 7 Nernst	30=102 H.P.	..	13,543	23	Lg. 7 & 4, or 6, pr. 4 & 1½, or 2½*	Max. dem., flat rate, & cont.	176,840	3.4
..	630	533.5	Chloride, w. Highfield booster, 380 amp.-hrs.	Callender, triple conc. fibre, fdrs. lead covd. in c. i. pipes; dist. armd., triple conc. & 3-core	£37,793	6,666	12 arc ..	9=23 H.P....	30=990 H.P.	31,307	5	Lg. 7 & 2", pr. 4½ & 1½, tr. 1½.	Max. demand	643,251	1.95
..	26	..	Epstein	Bare copper, overhead	£1,132	..	38 inc.	..	..	..	..	Lg. 7½	Flat rate and contract	..	..
..	300	180	Max. dis. 50 KW.-	Callender, v. bitumen	£18,572	7,215	15 arc, 226 inc.	5=35 H.P....	..	9,358	14	Lg. 4½, pb. lg. 2.08, pr. 2½ & 2	1st rate ..	279,093	2.64
..	1,600	975	Hart, max. dis. 225 KW.- ..	Glover, armd., 3-core..	£87,000	40,315	..	87=914 H.P.	..	72,045	41	Lg. 6 & 2, or 4, pr. 2 & 1	Max. demand & flat ra e	906,909	2.98
..	768	..	Tudor, 50 KW.- for 10 hrs. ..	B.I. & H. and Callender, paper lead covd. triple conc., fdrs. and dist.	£38,000	5,804	9 arc ..	19 = 42 H.P.	..	6,304 (ex. tr.)	..	Lg. 4 & 3, pr. 2 to 1½, pb. lg. 3, tr. 1½ to 1	Flat rate & sl. scale	911,737	1.58
..	32	34	E. P. S., max. dis. 16 KW. ..	Glover, diatrine paper, lead covd., armd., and St. Helens dialite, armd.	£4,700	2,720	..	5=24 H.P....	..	3,200	100	Lg. 6, pr. 2	Flat rate ..	24,692	5.14
..	128	69	.. ..	Siemens, paper and v. bit., lead covd. and armd. ..	£17,955	4,120	2 arc, 120 inc.	6=14 H.P....	2=20 H.P. (pumping)	5,428	5.5	Lg. 5½, pr. 3, pb. lg. £425 p.a.	Flat rate ..	106,187	3.21
..	282	135	D. P., max. dis. 40 KW. ..	Callender, triple conc. armd. fdrs., 3-core dist. ..	£37,445	8,575	29 arc; inc. & Nt.=461 8-CP.	46=157 H.P.	..	15,130	30	Lg. 6 & 4, or 5½, pr. 4 & 1½, or 2½*	Max. dem., flat rate & contract	149,479	3.72
..	700	310	E.P.S., 290 KW.	V. bit. conc. and single, in bitumen casing	£62,489	11,480	104 arc, 278 inc.	11=71H.P....	..	16,259	..	Lg. 5, pr. 3..	Flat rate ..	207,598	..
..	328	141	.. ..	Callender and Glover conc....	£27,500	13,037	15 arc, 2 Nernst	8=9½ H.P. .	..	12,571	17½	Lg. 4 w. dis., pb. lg. £23, pr. 2	Flat rate with discount	142,956	3.4
..	65	70	Chloride..	Callender, v. bit.	..	4,100	..	10=35 H.P.	..	5,226	..	Lg. 5½, pr. 2½ to 1½ ..	Sliding scale	..	..
M.	1,410	535	E. P. S., max. dis. 100 KW...	Callender armd. conc. and triple conc., direct in ground	£62,233	22,428	60 arc, 560 inc., 62 Nernst.	123=939 H.P.	..	45,414	28	Lg. 3½, pr. 2 to 1, pb. lg. arc £18, inc. 56/-	Flat rate & sliding scale	730,177	2.37
..	450	200 tr., 50 lg.	N. S. Electric Storage. Tr 200 KW., lg. 30 KW.	B. I. & H., 3-core lead covd., paper, laid solid	£90,000	3,000	20 arc ..	10=66½ H.P.	20=500 H.P.	19,112	..	Lg. 5, pr. 3 & 1½, pb. lg. £18 avge.	Flat rate & max. demand	..	..
..	1,000	675	Tudor, 118 KW. for 5 hrs. ..	Callender solid, 3-wire	£59,000	19,816	12 arc, 24 inc.	170 H.P. ..	18=450 H.P.	34,388	12	Lg. 4 to 3, pr. 2½ to 1½, tr. 2	Sliding scale	690,044	2.846
ster	145	81	D. P. 500 KW. hrs.	Callender, fibre, lead covd., armd.; triple conc. fdrs., 3 core dist.	£40,000	4,150	..	12=564 H.P.	..	5,500	..	Lg. 7 & 3, or 6, pr. 2½ & 1	Max. demand and flat rate	..	..
..	6,500	3,000	Tudor, max. dis. 1,050 KW...	Silvertown, v.r. in pipes, A.C., v.r. in troughing, D.C. ..	£405,430	..	..	..	..	120,253	18	Lg. 4½ to 1, pr. 2½ to 1 ..	Max demand, flat, & contract	3,259,380	2.18
4	16,250	11,200	Tudor, max. dis. 1050 KW...	Callender and B.I. & H.; h.p. fdrs. 3-core lead covd. armd., in ducts and solid in iron troughs; dist., v. bit. and ppr. 3-core, solid in c'ware troughs.	£1,147,405	184,000	1,000 eq. 8-C.P.	665,000 eq. univ. 8-C.P.		850,000	Over 130	Lg. 4½ & 1, pr. 1½, tr. 1½	Max. demand & sl. scale	17,132,153	1.30
..	60	55	E. P. S., 41 KW.-hrs.	Callender feeders lead covd. laid solid, dist. lead covd. and armd. laid direct	£5,000	2,968	..	..	..	2,968	..	Lg. 6, pr. 3	Flat rate ..	27,802	6
..	350	199	D. P., max. dis. 40 KW. ..	Callender, fdrs. triple conc., dist. 3-core, all lead covd. and armd. direct.	£26,378	9,591	12 arc ..	2=5½ H.P....	..	16,721	20	Lg. 7 & 4, pr. 4 & 1½ ..	Max. demand	121,005	6.017
..	390	205	2 D. P., max. dis. 144 KW., and 48 KW.	Callender, jute fdrs. 3-core., dist. 3-core, lead covd. armd. direct. H.T. trunk to Cowes, 3 single v. bit. solid in iron trough	£77,408	..	30 arc, 60 inc., 5 Nernst	30=97 H.P....	..	22,045	86	Lg. 7 & 4, or 6, pr. 4 & 1½, or 2½	Max. demand & flat rate	232,419	4.2
Sie-	1,050	749	Chloride, 1,530 amp.-hrs. ..	Siemens, and Glover	£103,000	44,017	76 arc, 6 inc.	16=60 H.P....	..	46,650	..	Lg. 5½ to 3, pr. 2 to 1 ..	Sliding scale	1,572,362	2.77
..	180	78	D. P., max. dis. 168 KW. ..	Callender, single cables laid solid	£32,588	3,544.	144 Nernst..	8=27 H.P....	..	4,511	..	Lg. 7 & 3, or 6, pr. 4 & 1½, or 2½	Max. demand & flat rate	29,015	
..	150	100	Tudor, max. dis. 120 KW. ..	Callender, B.I. & H., fdrs. v. bit. solid; dist. v. bit. solid, paper lead covd., and aluminium overhead	£9,783	2,846	31 arc; 81 inc.	23=56 H.P....	..	5,594	..	Lg. 6, pr. 4 to 2" ..	Flat with disc., scale & cont.	70,158	4.0
..	1,140	602	Tudor, max. dis. 294 KW. ..	Crompton, bare copper in culverts; Callender and B.I. & H. triple conc. single laid solid	£100,005	36,885	..	351 H.P.	..	47,433	16	Lg. 6 & 3, priv. houses 4½, pr. 2 with dis.	Max. demand, flat rate & disc.	569,671	3.75
tt	245	174	Pritchetts & Chloride, max. dis. 13 KW. Sub-stn. Tudor, 572 KW.	B.I. & H., and Glover, conc. & triple conc., paper, lead covd., armd., direct.	£29,292	11,600	59 inc.	36=227 H.P.		18,123	23	Lg. 6 & 4, pb. lg. 2½, pr. 2 and 1	Max. demand	195,485	3.55
..	2,834	1,694	E. P. S., max. dis. 300 KW. ..	Bare copper and B.I. & H.	£236,701*	102,000	16 arc, 9 Nernst	260=1,104 H.P.	..	134,7-9	..	Lg. 4½, pb. lg. 1, pr. 3 to 1	Flat rate & scale	2,097,902	3.46
..	8,723	5,092	E. P. S., max. dis. 100 KW. ..	Callender, v. bit. armd. and solid	£417,272	214,734	160 arc. ..	574=2,014 H.P.	..	267,401 ex. tr.	..	Lg. 5 & 1½, pb. lg. 5 & 1½, pr. 1½, tr. 1½.	Max. demand & flat rate	8,469,921	2.07
ns,	375	230	Hart, max. dis. 42 KW. ..	Triple conc. ppr.; fdrs. in ducts; dist. armd. direct; Johnson & Phillips, Callender and St. Helens	£23,000	12,231	20 arc, 115 Nernst.	23=111 KW.	..	16,093	..	Lg. 6 & 3, or 5, pr. 3 & 1½, or 2½	Max. demand flat rate & scale	196,028	4.27*
..	150	100	.. ..	Bare copper overhead, and conc. fdrs. armd. direct, B I. & H.	£8,878	3,100	203 inc. ..	..	..	3,500	4	Lg. 4, 4½ & 6, pb. lg. contract	Sliding scale & contract	..	..
..	5,232	1,743	.. ..	Bare cpr. in culvert, paper bit. and v.r. in pipes, solid, B.I. & H.	£216,882	..	..	..	..	54,154	..	Lg. 4 & 1½ pr. 2 to 1½, tr. 1½, pb. lg. 2½	Max. demand flat rate & scale	2,869,812	2.53
&	253	130	E. P. S., max. dis. 7 KW. ..	Callender, bit. lead covd.	£10,578	5,200	..	3=12 H.P. ..	..	..	6	Lg 7 & 3, pr. 3"	Max. demand & flat rate	96,853	6.2
n-	34	17	Chloride, max. dis. 14 KW. ..	Bare copper	£2,000	1,014.	22 inc. ..	1=5 H.P.	..	1,182	18.2	Lg. 6½, pb. lg. 4, pr. 3 ..	Flat rate with rebate	12,530	5.9
..	1,200	1,047	E. P. S., max. dis. 200 KW. ..	Silvertown h.p. fdrs., v.r. and diatrine, Callender l.p. dist. armd.	£145,401	60,954.	32 arc, 48 inc.	42=130 H.P.	..	65,276	17	Lg. 6, pr. 3½, pb. lg. 2.3	Flat rate with discount	847,136	5.16
1	1,200 (lg.) 1,800 (r.)	727 (lg.) 550 (tr.)	.. ..	Callender, v. bit. conc. fdrs., conc. armd. dist.	£149,000	49,950.	91 arc* ...	18=222 H.P.	100=2,500 H.P.	56,166	8.5	Lg. 4, pr. 2½, pb. lg. £35, tr. 2 to 1½	Flat rate & scale	1,757,800	3.8†
..	1,050	660	Tudor, max. dis. 150 KW. ..	Fdrs. in ducts, dist. solid, all triple conc. lead covd. B.I. & H.	£78,155	34,437	238 arc, 69 Nernst	109=879 H.P.	..	64,709	63.2	Lg. 3½, pr. 1, pb. lg. .9d.	Flat rate ..	1,930,348	1.72
..	1,000	190	Tudor, max. dis. 75 KW. ..	B.I. & H. conc. and single lead covd. ppr. in C.I. pipes, and solid.	£31,000	2,050.	13 arc, 500 inc.	6=20 H.P.	..	9,500	50	Lg., priv. & pb., 3, pr. 1½d.	Flat rate and contract	193,687	1.75
..	300	119	Chloride, 400 KW. hrs. ..	Callender, triple conc. solid in wood	£29,500	8,198	24 arc, 101 inc.	1=3 H.P.	..	9,108	24	Lg. 4½, pr. 3, pb. lg. contract	Flat rate and contract	180,309	3.76
..	100	46	Hart, 210 amp.-hrs.	Ppr. lead covd., fdrs. triple conc., dist. 3-core, solid in wood	..	2,991.	6 arc	.. ..	.. ..	2,480	..	Lg. 7 & 3	Max. demand	..	..
..	1,175	420	E. P. S., 600 amp.-hrs. ..	Callender, triple conc. fdrs., v. bit. dist. solid, armd. for ducts, lead covd. for inc. ltg.	..	23,051	70 arc, 59 inc.	140 H.P. ..	40=1,400 H.P.	29,076 ex. tr.	..	Lg. 4, pb. lg. 1½, pr. 2 ..	Flat rate ..	..	..
..	840	402	2 Pritchetts & Gold, max. dis. lg. 72 KW.; tr., 72 KW.	Callender, single, v. bit., fdrs. solid in wood troughs, dist. in Callender-Webber casing	£48,918	14,889.	73 arc, 6 Nernst	23=54 H.P.	28=560 H.P.	31,668	..	Lg. 4½ & 4, pr. 1½, pb. lg. £12, tr. 2½ to 1½	Flat rate and scale	445,728	3.02
..	2,300	807	Tudor, 237 KW. for 5 hrs. ..	Ppr. lead covd. conc., B.I. & H. and Callender.. ..	£198,000	80,600	73 arc	..	78=1,700 H.P.	74,200	..	Lg. 4½, pr. 3, tr. 2.5 ..	Flat rate ..	1,279,743	3.38
..	169	116	Tudor, max. dis. 25 KW. ..	Callender, bare copper, and armd.	£11,412	6,612.	6 arc, 1 Nernst	7=11 H.P....	..	7,015	10	Lg. 6, pb. lg. 4", pr. 3 ..	Flat rate ..	76,926	5.71
..	600	..	.. ..	Henley, paper, laid solid	£55,000	..	40 arc ..	10 H.P. ..	24=888 H.P.	..	..	Lg. & pr. 6 & 1½, pb. lg. & tr. 1½	2-rate meter	..	..
ons	3,336	2,348	Tudor, max. dis. 100 KW. ..	Rubber, ppr., and diatrine	..	149,840	264 arc, 146 inc.	152=341 H.P.	..	183,930	..	Lg. 4½, pr. 1½, pb. lg. £18 & £3 3s.	Flat rate ..	2,717,210	..
es,	1,460	1,300	.. ..	B.I. & H., conc. armd. solid	£82,676	10,500	23 arc, 277 inc.	21=161 H.P.	8=200 H.P.	87,594	13	Lg. 4, pb. lg. 2, pr. 1, tr. 1 to ½	Flat rate ..	2,939,590	1.25
ps ns,	1,970	..	Tudor, 600 amp.-hrs. ..	Bare cpr. and ppr.; A.C. mains conc.	£182,750	58,779.	42 arc	.. ..	.. ..	59,410	..	Lg. 4 & 2, pr. 1½	Max. demand & sl. scale	..	..
..	100	52	Tudor, 280 amp.-hrs. ..	V. bit. single solid	£22,000	2,465	15.	.. ..	.. ..	..	..	Lg. 8 & 3	Max. demand	..	..
..	240	..	British Accumulator Co., max. dis. 88 KW.	Callender, ppr. lead covd., lg. fdrs. (3 core) and tr. fdrs. in ducts, 3-core dist. laid solid in Howard troughing	..	3,000	.. ..	3=8 H.P. ..	.. ..	..	..	Lg. 5, pr. 2, tr. 1½ ..	Sliding scale	..	..
..	250	..	D.P.	Henley, ppr. lead covd., fdrs. triple conc. laid solid, dist. 3-core, solid and armd. direct	..	..	.. ..	.. ..	.. ..	..	..	Lg. 7 & 3, pr 2	Max. demand & flat rate	..	..
..	750	306	Tudor, max. dis. 108 KW. ..	B.I. & H. paper lead covd., triple conc.	£88,712	23,094	108 arc, 418 inc.	3=9 H.P.	..	22,319	8.4	Lg. 4½, pr. 2 & 1½, pb. lg. £18 & £3½	Flat rate ..	547,780	Priv. 4.43 Pub. 2.62
5	2,675	1,935	Tudor, max. dis. 160 KW. ..	Conc. and single lead covd. and armd., also Simplified Underground Conductor system	£131,257	60,000	..	200=1,003 H.P.	..	90,000 approx.	28	Lg. 6 to 3, pr. 3 to 1½ ..	Sliding scale	1,018,000	3.78
..	435	184.	.. ..	Henley & Glover paper, conc., lead covd., armd. ..	£21,584	8,778.	311 inc.	25=161 H.P.	..	15,844	..	Lg. 5½ & 5, pr. 1½ & 1, pb. lg. £3	Flat rate or 2-rate meter	265,717	2.64
..	280	127	.. ..	Callender bit., conc. lead covd	£30,000	12,300	4 inc. (7 amp.)	3=14 H.P....	..	12,600	..	Lg. 7 & 4, pr. 3	Max. demand and flat rate	..	..
..	495	..	Hart, 400 amp.-hrs.	Triple conc. fdrs. and dist., solid	£22,893	2,100	58 arc	3	.. ..	3 045	..	Lg. 6 & 3, or 4½	Max. demand and flat rate	..	..
st-	1,150	480.	Tudor, 1,200 amp.-hrs.: max. dis. 700 amps for ½ hour	Bare cpr. strip, armd. rubber laid direct by Glover, Henley, and Silvertown, and Callender solid system	£88,080	42,023 inc. lg.	..	2½=141 H.P.	..	43,906	20	Lg. 6, pr. 2½	Flat rate ..	473,771	..
n-	1,976	391.5 lg. 517 tr.	Pritchetts & Gold, 600 amp.-hrs.	Glover diatrine and B.I. & H., ppr., lead covd., fdrs. s and 3-core in pipes and ducts, dist. armd. direct	£63,414	23,710	..	Appx. 50=376 H.P.	103=3,502 H.P.	28,852 exc. tr.	8.40	Lg. 6 & 2, or 4½, pr. 2 to 1, tr. 1½ to 1	Max. demand flat rate & sc.	1,160,593	1.98
	80	43.8.	Hart, max. dis. 37 KW. ..	Silvertown vulc. rubber, laid solid	£5,255	1,500.	35 Nernst ...	3=7 H.P. ..	..	2,032	25	Lg. 7, pb. lg. 2½, pr. 3 ..	Flat rate .	26,308	6.11
..	1,208	751.	E.P.S., 57 KW. for 5 hours. ..	Callender, conc., v. bit, and Glover diatrine	£47,905	17,900.	..	29=80 H.P.	60=1,500 H.P.	54,111	5.2	Lg. 4½ to 4, pr. 1½ to 1, tr. 1½	Flat rate ..	1,227,007	2.09
..	34	24	.. ..	B.I. & H. lead covd. armd. direct, lead covd. in pipes on pier	£3,000	58	35 arc, 22 inc.	.. ..	.. ..	..	..	.. ..	.. ..	.. ..	..
..	43	..	.. ..	B.I. & H. ppr., lead covd. in pipes	..	1,000.	14 inc. ..	1 H.P. ..	..	1,050	..	Lg. 6	Flat rate ..	..	
..	180	100	E.P.S., 700 amp.-hours ..	B.I. & H., 3-core laid solid..	£12,000	4,000	70 Nernst ..	.. ..	.. ..	5,300	41	Lg. 6, pb. lg. 4, pr. 3 ..	Flat rate and sliding scale	22,980	..
..	310	195.	.. ..	Henley, paper lead covd., laid solid	£12,000	8,052	..	11=13½ H.P.	..	8,094	50	Lg. 5½, pr. 2½ & 3 ..	Flat rate ..	88,497	5
	85	62.	.. ..	Glover ppr., lead covd., armd., laid direct	£4,500	5,000.	..	.. ..	.. ..	5,000	..	Lg. 4 & fixed charge, small houses 5	Hopkinson	42,600	..
..	192	85	D.P., max. dis., 144 KW. ..	Callender; fdrs. triple conc.; h.p. fdrs. conc.; dist. 3-core; lead covd. and armd., direct	£54,580	8,905.	50 inc.	23 H.P. ..	..	9,945	67	Lg. 7 & 4, or 6, pr. 4 & 1½, or 2½	Max. demand & flat rate	78,505	4.95
..	750	179 lg., 400 tr.	Tudor, 89 KW.	B.I. & H. and Callender, conc. fdrs., single dist., solid in wood; paper ins., lead or v. bit. covd.	£99,005	15,065	34 arc, 58 inc., 100 Nernst	12=30 H.P.	*	22,694	..	Lg. 7 & 2, or 5½, pb. lg. & pr. 3½, tr. 2 to 1½	Max. demand & flat rate	580,500	3.6
	80	..	Hart, max. dis. 30 KW. ..	Callender, 3-core, lead covd.	£6,000	2,000	..	14 H.P. ..	..	2,260	..	Lg. 5, pr. 2	Flat.. ..	..	..
..	1,340	1,007	Chloride, max. dis. 510 KW....	B.I. & H., and St. Helens, ppr., ld. covd. fdrs. single & tri. conc. solid, dist. single, solid conc. & single armd. direct	£127,956	24,406.	35 arc, 70 inc.	160=864 H.P.	..	54,043	23.8	Lg. 4½, pr. 2 & 1, pb. lg. £15, tr. 1.11 & .87	Lg. flat, pr. m.d., tr. scale	2,080,744	1.85
	100	48.	Tudor, max. dis. 100 KW. ..	Paper, lead covd., laid solid in wood; B.I. & Helsby and Glover	£9,000	3,262.	2 arc, 9 inc., 6 Nernst	1=2 H.P.	..	3,507	31	Lg. 6 & 3, pr. 3 & 1½, pb. lg. 2½	Max. demand & flat rate	41,980	4.66
..	6,520	3,600	Tudor, max. dis. 270 KW. ..	Glover, D.C., lead covd. ppr. single, fdrs. in ducts, dist. solid, A.C., lead covd. ppr. conc. in c.-ware pipes	£545,887	195,624	116 arc ..	270=2,260 H.P.	402=11,080 H.P.	444,242	22.4	Lg. 3½*, pb. lg. 1.22, pr. 2 to 1, tr. 1.5	Flat rate & sliding scale	9,000,310	1.792
..	600	249	D.P., 315 KW. hrs.	Callender, 3-core and triple conc. armd. direct	£61,796	20,468	35 inc.	36=122 H.P.	..	28,033	35	Lg. 7, 4 & 2, pr. 4 & 1½ ..	Max. demand	397,511	3.68
				B.I. & H., Callender & St. Helens, ppr., lg. & armd.	£14,000	7,200	..	10=20 H.P.				Lg. 6 & 6½, pr. 4 ..	Flat rate	69,704	5.47

AL REVIEW" LIST OF ELECTRICITY SUPPL

r of ing	Engineer.	Pressure of supply, volts.	Frequency and Phase.	Boilers and Auxiliaries.	Engines.	Generators.	Total Capacity in KW.	Max. load recorded in KW.	Storage Battery.	Mains.
02	W. J. Maybery ..	230	Direct ..	1 Cornish, 1 Lanc.	1 Browett-Lindley, 1 Howden ..	2 Bertram Thomas	120	89	Tudor, max. dis. 23 KW. ..	Glover, lead covd. and armd. direct ..
07	J. Brown ..	230 & 460	Direct ..	3 Lanc.	1 Willans, 1 Alley & MacLellan, 1 Reavell	1 Siemens, 1 Mather & Platt, 1 Bertram Thomas	250	..	Tudor	Glover conc. and single, B.I. & Helsby 2-c direct
04	H. Morton ..	220 & 440	Direct ..	6 B. & W. (2 with 4-cell Beaman & Deas destructor), econ.	3 Belliss, 3 Allen	4 Silvertown, 2 Crompton	700	460	Hart, max. dis. 36 KW. ..	Henley, Glover, and B. I. & H., triple conc. f dist. armd., lead covd., direct
04	R. V. Macrory ..	230 & 440 arc. lg. 2,500	Direct ..	5 Lanc.	3 Brown & Sons, 4 Allen	6 Siemens arc, 4 B. T.-H.	880	236	E. P. S., max. dis. 670 KW. ..	Western Electric, paper, lead covd., conc. ducts, dist. solid
03	F. Worrall ..	220	Direct ..	3 Lanc.	3 Browett-Lindley	5 Lanc. D. & M. Co.	450	242	.. ..	B.I. & H., lead covd., fdrs. triple conc., so triple conc., armd. direct
01	W. Langford ..	230	Direct ..	2 B & W., econ.	2 Belliss	2 E. C. C.	300	69	Chloride, 160 KW.	Callender, vulc. bitumen, solid .. ..
04	W. H. Allen ..	220 & 440	Direct ..	2 Danks marine dryback	2 Brush-Parsons turbines	2 Brush	500	147	Pritchetts & Gold, max. dis. 65 KW.	Henley, paper, lead covd., 3-core dist., conc. f
01	G. A. Bruce ..	230 & 460	Direct ..	4 B. & W., suphtrs., cond., 1 Musgrave, Horsfall 4-cell destructor	2 Musgrave, 2 Browett-Lindley, 1 Willans	4 B. T.-H., 1 Lanc. D. & M. Co. ..	1,475	550	.. ..	Callender and St. Helens, fdrs. armd. direc bit. solid
01	W. H. Cooke ..	250 & 500	Direct ..	2 Lanc., cond., econ., suphtr., water softener ..	4 Allen	5 Allen	297	285	Chloride, max. dis. 120 KW...	Callender, v. bit. 3-core dist.; fdrs. conc. St. Helens Dialite
00	Glynn Salter ..	240	Direct ..	2 B. & W., suphtrs.	2 Belliss	2 Parker	124	77.5	D. P., max. dis. 22 KW. ..	Callender, triple conc. fdrs., 3-core dist., all a
00	P. T. Kimmins	100	100~, 1-ph.	1 loco.	1 Sherman (steam), 1 Escher Wyss, 3 Hett (water)	2 Brush, 1 E. C. C.	150	67	.. ..	Glover and Callender, ppr., fdrs. 2-core, dist.
99	D. E. McDonnell	230	100~, 1-ph.	1 Cornish	1 water turbine, 1 water wheel, 1 Brush	1 B. T.-H., 1 Brush, 1 Ediswan ..	150	47	.. ..	Glover conc. lead covd. and armd... ..
01	E. E. Hoadley ..	230 & 460	Direct ..	4 Paxman dryback	5 Peache	3 Parker, 2 Westinghouse	750	351	Chloride, max. dis. 150 KW.	Callender, single, solid in iron trough ..
04	J. Chandler*	230 & 460	Direct ..	Gas	2 Crossley gas engines	4 Bruce Peebles	80	37.5	Chloride, max. dis. 75 KW. ..	Callender .. ..
04	W. J. R. Baker ..	100 & 200	50~, 1-ph.	2 Lanc., Wilton furnaces, used as destructors ..	2 Belliss	2 Dick Kerr	200	40	.. ..	Glover, Diatrine, conc., lead covd. and armd.
03	S. L. Pearce	100, 200, & 400 D.C. 6,500 A.C.	Direct .. / Direct .. / 50~, 3-ph. 6,500 volts	*Dickinson Street*:—18 Lanc., 4 B. & W., stokers, cond., econ. / *Bloom Street*:—11 B. & W., stokers, cond., econ. / *Stuart Street*:—36 B. & W., stokers, cond., clg. trs., econ.	4 Goodfellow, 2 Musgrave, 2 Ferranti, 4 Parsons turbines / 4 Musgrave .. .. / 6 Yates & Thom, 2 Wallsend Slipway, 3 Willans	5 E. C. C., 3 Siemens, 2 Westinghouse, 2 Parsons / 4 Westinghouse .. .. .. / 11 Electrical Co. (A. E. G.)	10,600 / 7,200 / 16,500	18,745	Chloride, 480 KW.-hrs. ..	Bare copper, paper, v. bit., Callender, B.I. & H Western Electric, and Johnson & Phillips
03	E. Holcombe Hewlett	240 & 480 550-600 tr.	Direct ..	3 Lanc., 2 B. & W., econ., stokers, cond., forced draught, Heenan 6-cell destr.	3 Alley & MacLellan	3 Parker	720	150	Tudor, max. dis. 100 KW. ..	Western Electric, triple conc. ppr. lead covd., in e'ware and iron trough
03	R. Humphries ..	240 & 480	Direct ..	4 B. & W.	2 Allis, 2 Belliss	B.T.-H., 2 3-ph., 2 D.C.	1,000	150 (ex. tr.)	Tudor, max. dis. 25 KW. ..	Callender, triple conc. .. .. ..
03	C. F. Bottomley	240 & 480	Direct ..	2 Davey Paxman loco., Boby heater	2 Belliss	2 Parker	90	64	Pritchetts, 400 amp.-hrs. ..	Callender, fdrs. tripl conc. bit. fibre, ld. cov dist. 3-core lead covd. and armd., direct
04	.. ..	225 & 450	Direct ..	2 Crossley (pressure) gas producers .. .	2 Crossley	2 Crompton	66	..	A. B. P., max. dis. 70 KW. ..	Callender, bitumen, single laid solid ..
00	W. H. Russell ..	240 & 480	Direct ..	3 B. & W., suphtrs., stokers, econ., cond. ..	3 Parsons turbines	3 Parsons	300	112.5	D. P., max. dis. 130 KW. ..	Callender, lead covd. steel taped, triple conc. co e dist.
01	A. J. L. Plunket	230 & 460	Direct ..	4 B. & W., cond.	4 Browett-Lindley	3 Peebles, 1 Silvertown	630	533.5	Chloride, w. Highfield booster, 380 amp.-hrs.	Callender, triple conc. fibre, fdrs. lead covd. pipes; dist. armd., triple conc. & 3-core
06	J. A. Hill ..	110	Direct ..	1 Paxman loco.	1 Paxman	1 Crompton	26	..	Epstein	Bare copper, overhead .. .. ..
02	H. M. Taylor ..	220 & 440	Direct ..	3 Lanc., Meldrum 3 cell dest.	2 Willans, 1 Belliss	3 Mavor & Coulson	300	180	Max. dis. 50 KW.	Callender, v. bitumen .. .. ..
01	John Senior ..	220 & 440	Direct ..	6 Lanc., stokers and econ.	1 Davy Bros., 3 Browett Lindley, 1 Brush-Parsons turbine	2 Jackson, 2 Witting, 1 Brush ..	1,600	975	Hart, max. dis. 225 KW. ..	Glover, armd., 3-core .. ..
02	S. Pauls	220 & 440	Direct ..	3 Lanc, suphtrs., cond. (Meldrum 2-cell dest. being constructed).	3 Belliss	3 Siemens	768	..	Tudor, 50 KW. for 10 hrs. ..	B.I. & H. and Callender, paper lead covd. tri fdrs. and dist.
03	Charles Mounsey	220	Direct ..	.. ..	2 Hornsby-Akroyd crude oil engines	2 Birkett	32	34	E. P. S., max. dis. 16 KW. ..	Glover, distrine paper, lead covd., armd., and S dialite, armd.
00	A. W. Blake ..	100 & 200	60~, 1-ph.	1 Cornish, 1 Paxman loco. and water power ..	4 Ransome	4 Siemens	128	69	.. ..	Siemens, paper and v. bit., lead covd. and arm
01	Harold Hale .	240 & 480	Direct ..	3 B. & W., superheaters	3 Belliss	3 Parker	282	135	D. P., max. dis. 40 KW. ..	Callender, triple conc. armd. fdrs., 3-core dist.
98	W. H. Hall ..	220	Direct ..	2 Lanc., 2 B. & W.	5 Peache, 2 Parsons turbines ..	5 Parker, 2 Parsons	700	310	E.P.S., 200 KW.	V. bit. conc. and single, in bitumen casing
98	J. E. Ellis ..	100 & 200	60~, 1-ph.	3 Lanc., stokers and econ.	2 Pollitt & Wigzell, 1 Belliss ..	2 E. C. C., 1 Fowler	238	141	.. ..	Callender and Glover conc. .. .. ..
04	W. H. Bibby (Res.)	230 & 460	Direct ..	1 Ruston Proctor	1 Scott & Mountain	1 Scott & Mountain	65	70	Chloride	Callender, v. bit. .. ..
01	S. Williams ..	230 & 460	Direct ..	3 Lanc., 1 B. & W., feed htr.	7 Willans	4 Mavor & Coulson, 2 Lanc. D. & M. Co., 1 Siemens	1,410	535	E. P. S., max. dis. 100 KW. ..	Callender armd. conc. and triple conc., direct
04	William Bain ..	230 & 460 lg. 500 tr.	Direct ..	3 Heenan & Froude water tube	3 Davey Paxman	3 Lanc D. & M. Co.	450	200 tr., 50 lg.	N. S. Electric Storage. 200 KW., lg. 30 KW.	B. I. & H., 3-core lead covd., paper, laid solid
02	W. Allan Fraser	230 & 460	Direct ..	2 Lanc., stokers, econ., Meldrum 4-cell dest.	4 Willans	4 Bruce Peebles	1,000	675	Tudor, 118 KW. for 5 hrs. ..	Callender solid, 3-wire .. .. ..
05	H. W. Bush ..	240 & 480	Direct ..	Dowson gas plant	1 Campbell gas engine, 1 25-H.P. water wheel, 2 Dell water turbines	Parker, 1 water driven booster balancer, 1 generator	145	81	D. P. 500 KW. hrs.	Callender, fibre, lead covd., armd.; triple conc core dist.
00	W. D. Hunter ..	100 A.C.; 240 & 480 D.C.	80~, 1-ph., and direct	11 Lanc., econ. for six, 5 Stirling	15 Parsons turbines	15 Parsons	6,500	3,000	Tudor, max. dis. 1,050 KW. ..	Silvertown, v.r. in pipes, A.C., v.r. in troughin
00	R. P. Sloan (Man.)	240 & 480 D.C., 440 A.C.	40~, 3-ph., and direct	8 B. & W., 10 B. & W. marine type, ch. grate stokers, cond.	3 Wigham Richardson, 1 Wallsend Slipway; 1 Brown Boveri-Parsons turbine, 4 Parsons turbines	4 B T.-H., 1 Brown-Boveri, 4 Parsons	16,250	11,300	Tudor, max. dis. 1050 KW. ..	Callender and B.I. & H.; h.p. fdrs. 3-core l armd., in ducts and solid in iron troughs; di and ppr. 3-core, solid in e'ware troughs
04	J. F. Shoolbred	230	Direct ..	.. ..	2 Andrews gas engines	2 Electric Construction Co.	60	55	E. P. S., 41 KW.-hrs.	Callender feeders lead covd. laid solid, dist. le and armd. laid direct
99	F. A. Simpson ..	210	Direct ..	4 Paxman (2 loco., 2 Economic)	2 Willans, 1 Allen, 1 Belliss ..	3 Parker, 1 Allen	350	199	D. P., max. dis. 40 KW. ..	Callender, fdrs. triple conc., dist. 3-core, all l and armd. direct.
and 03	A. E. Mayes (Eng. & Man.) F. T. Crowe (Res. Eng.)	240 & 480	Direct ..	2 B. & W., 1 Sugden, mech. stokers, suphtrs., feed heater	3 Belliss	4 Parker	390	205	2 D. P., max. dis. 144 KW., and 48 KW.	Callender, jute fdrs. 3-conc., dist. 3-core, le armd. direct. H.T. trunk to Cowes, 3 singl solid in iron trough
05	H. Collings Bishop	100 & 200	87.5~, 1-ph.	8 Lanc., stokers, cond., econ.	4 Uckside Eng. Co., 1 Brush, 3 Fowler, 1 Belliss	1 Mordey, 7 Hall (Fowler), 1 Siemens	1,050	749	Chloride, 1,530 amp.-hrs. ..	Siemens, and Glover .. ..
02	F. C. Pay ..	240 & 480	Direct ..	2 B. & W., suphtrs.	2 Belliss	2 Parker	180	73	D. P., max. dis. 168 KW. ..	Callender, single cables laid solid ..
99	F. R. Batty .	220	Direct ..	1 Paxman Economic, 1 Galloway	1 Alley & MacLellan, 1 Willans ..	1 G.E.Co., 1 E.C.C.	150	100	Tudor, max. dis. 120 KW. ..	Callender, B.I. & H., fdrs. v. bit. solid; dis solid, paper le d covd., and aluminium overl
01	G. H. Jackson ..	210 & 420	Direct ..	2 Lanc., 2 B. & W., stokers, econ., suphtrs. ..	5 Willans	5 Crompton	1,140	602	Tudor, max. dis. 234 KW. ..	Crompton, bare copper in culverts; Calle B.I. & H. triple conc. single laid solid
97	W. Boyd ..	220 & 440	Direct ..	*	4 Crossley gas engines*	5 Laurence-Scott, 1 Mather & Platt	245	174	Pritchetts & Chloride, max. dis. 18 KW. Sub-stn. T. dor, 572 KW.	B.I. & H., and Glover, conc. & triple con lead covd., armd., direct
03	F. M. Lea ..	230 & 440	Direct ..	7 B. & W., 4 dryback, econ.	6 Willans, 1 Parsons turbine ..	3 Laurence-Scott, 3 Siemens ..	2,834	1,694	e. P. S., max. dis. 300 KW. ..	Bare copper and B.I. & H. .. .. ..
04	H. Talbot ..	200 & 400	Direct ..	16 Lanc., 14 dryback, econ., feed. htr., 6 B. & W. with 12-cell Manlove dest.	32 Willans	32 Siemens	8,723	5,092	E. P. S., max. dis. 100 KW. ..	Callender, v. bit. armd. and solid .. ..
00	S. C. Gibson ..	230 & 440	Direct ..	3 B. & W., economiser, cond.	2 Willans, 1 Paxman	1 Johnson & Phillips, 1 Siemens, 1 E.C.C.	375	280	Hart, max. dis. 42 KW. ..	Triple conc. ppr.; fdrs. in ducts; dist. armo Johnson & Phillips, Callender and St. Hele
01	T. Thomas ..	100 to 220	40~, 1-ph., & direct	2 B. & W.	1 Robey, 2 Paxman	2 Parker, D.C.; 2 Siemens A.C. ..	150	100	.. ..	Bare copper overhead, and conc. fdrs. arm B. I. & H.
04	S. W. Newington	210 & 420	Direct ..	8 Lanc., 8 Marine, 3 Climax, cond., 8 destructor cells	16 Willans, 1 Parsons turbine ..	4 Hall, 12 Siemens, 1 Parsons ..	5,232	1,743	.. ..	Bare cpr. in culvert, paper bit. and v.r. in pip B.I. & H.
95	E. B. Smith ..	220	Direct ..	2 loco., 2 B. & W., ch. gr. stoker	2 Marshall, 2 Belliss, 1 Scott & Mountain	2 Parker, 1 Siemens, 1 Scott & Mountain, 1 McClure	253	180	E. P. S., max. dis. 7 KW. ..	Callender, bit. lead covd. .. .. ..
02	B. Barber ..	230	Direct ..	1 loco., 1 Cornish	1 Paxman, 1 Hornsby	1 Laurence Scott, 1 Harrison Engineering Co.	34	17	Chloride, max. dis. 14 KW. ..	Bare copper .. ..
02	F. H. Francis ..	100	Direct ..	5 loco., 2 Economic; cond.	5 McLaren, 1 Willans, 1 Belliss ..	7 Electric Construction Co.	1,300	1,047	E. P. S., max. dis. 200 KW. ..	Silvertown h.p. fdrs., v.r. and diatrine, Calle dist. armd.
99	C. F. Parkinson	200 A.C. 500 D.C. (tr.)	50~, 1-ph. & direct	8 B. & W., stokers	1 Adamson, 2 Ferranti, 2 Peache, 2 Davey Paxman	2 Ferranti, 2 Schuckert, A.C.; 1 Schuckert, 2 Bruce Peebles, D.C.	1,200 (lg.) 1,800 (tr.)	727 (lg.) 550 (tr.)	.. ..	Callender, v. bit. conc. fdrs., conc. armd. dist.
02	H. B. Maxwell ..	240 & 480	Direct	4 B. & W., 1 Stirling, econ., Manlove Alliott 6-cell dest.	5 Belliss	4 Peebles, 2 Greenwood & Batley ..	1,050	660	Tudor, max. dis. 150 KW. ..	Fdrs. in ducts, dist. solid, all triple conc. le B.I. & H.
02	J. Slevin ..	230 & 460	Direct ..	3 Lanc., cond., clg. tr.	4 Belliss	2 Mather & Platt, 2 Dick Kerr ..	1,000	190	Tudor, max. dis. 75 KW. ..	B.I. & H. conc. and single lead covd. ppr. in C and solid.
00	S. L. R. Price ..	220 & 440	Direct ..	3 Lanc., 1 B. & W., stokers, econ., cond.	2 Easton	4 Easton	300	119	Chloride, 400 KW. hrs. ..	Callender, triple conc. solid in wood ..
01	S. G. Leech ..	230 & 460	Direct ..	2 B. & W., feed htr.	2 Brush Universal	2 Brush	100	46	Hart, 210 amp.-hrs.	Ppr. lead covd., fdrs. triple conc., dist. 3-core wood
01	J. Lambert ..	230 & 460	Direct ..	4 B. & W., cond., econ.	4 Willans, 1 Brush	3 Peebles, 2 Brit. Elec. Plant Co. ..	1,175	420	E. P. S., 600 amp.-hrs. ..	Callender, triple conc. fdrs., v. bit. dist. soli for [illegible], lead covd. for inc. ltg.
00	J. C. Gill ..	200 & 400	Direct ..	4 Lanc., cond., econ.	5 Willans, 1 Belliss	2 G.E.Co., 1 Peebles, 3 Crompton ..	840	402	2 Pritchetts & Gold, max. dis. lg. 72 KW.; tr., 72 KW.	Callender, single, v. bit., fdrs. solid in wood dist. in Callender-Webber casing
99	E. G. Okell ..	100 & 200	50~, 1-ph., D.C. for tr.	9 Lanc., stokers, econ., cond.	5 Belliss, 2 Ferranti	6 Ferranti, 3 Westinghouse	2,300	807	Tudor, 237 KW. for 5 hrs. ..	Ppr. lead covd. conc., B.I. & H. and Callender
06	..	103	Direct ..	3 loco., feed htr.	4 Willans	3 Crompton, 1 Parker	169	116	Tudor, max. dis. 25 KW. ..	Callender, bare copper, and armd. .. ..
04	J. E. Teasdel ..	220 & 440	Direct ..	3 B. & W., econ., Heenan 3-cell dest.	3 Combe-Barbour	3 Greenwood & Batley	600	..	.. ..	Henley, paper, laid solid .. .. ..
04	W. S. Foale ..	100	50~, 1-ph.	18 Lanc., stokers, econ., cond.	5 Yates & Thom, 3 Parsons turbines	4 Ferranti, 1 Brown-Boveri, 3 Parsons	3,336	2,348	Tudor, max. dis. 100 KW. ..	Rubber, ppr., and diatrine .. .. ..
01	R. P. Nash ..	100 A.C., 250 & 550 D.C.	100~, 1 ph. & direct	5 Lanc., stokers, suphtrs., econ., cond., clg. tr. ..	3 Browett-Lindley, 1 Alley and MacLellan, 1 Ferranti, 1 Willans	1 English Electric, 1 Peebles, 1 Silvertown, 3 Johnson & Phillips	1,460	1,300	.. ..	B.I. & H., conc. armd. solid .. ..
02	J. H. Tonge ..	250	50~, 1-ph., & direct	6 Lanc., 3 dryback	5 Belliss, 3 Willans	2 Clark-Muirhead, 2 Siemens, 2 E.C.C. direct, 2 E.C.C. altg.	1,070	..	Tudor, 600 amp.-hrs.	Bare cpr. and ppr.; A.C. mains conc. ..
00	W. H. Joyce ..	230 & 460	Direct ..	2 B. & W.	3 Belliss	2 B.T.H.	100	52	Tudor, 280 amp.-hrs.	V. bit. single solid .. ..
04	M. B. Henry ..	220	Direct ..	2 Lanc.	2 Browett-Lindley	2 Mather & Platt	240	..	British Accumulator Co., max. dis. 88 KW.	Callender, ppr. lead covd., lg. fdrs. (3 core) an in ducts, 3-core dist. laid solid in Howard t
05	M. Farrer ..	240 & 480	Direct ..	2 Hornsby	2 Belliss	2 Parker	250	..	D.P.	Henley, ppr. lead covd., fdrs. triple conc. l dist. 3-core, solid and armd. direct
00	G. F. Pilditch ..	230 & 440	Direct ..	3 Lanc., stokers, econ., Heenan & Froude 6-cell dest.	3 Willans	4 Mather & Platt, 2 Dick Kerr. ..	750	306	Tudor, max. dis. 108 KW. ..	B.I. & H. paper lead covd., triple conc. ..
95	A. T. Cooper ..	200 A.C., 200 & 400 D.C.	67~, 1-ph. & direct	4 Lanc., 2 B. & W., econ., suphtrs.	3 Fowler, 5 Belliss, 2 Willans (gas)	3 Fowler, A.C., 8 E.C.C. and 5 Siemens D.C.	2,675	1,935	Tudor, max. dis. 160 KW. ..	Conc. and single lead covd. and armd., also S Underground Conductor system
99	W. J. Ferguson ..	200	66~, 1-ph.	Dowson gas plant	3 Premier, 1 Willans, gas engines	3 Johnson & Phillips, 1 E.C.C. ..	435	184.	.. ..	Henley & Glover paper, conc., lead covd., arm
01	W. S. Ross ..	200	50~, 1-ph.	2 B. & W., suphtrs., econ., detartariser	3 Allen	3 E.C.C.	280	127	.. ..	Callender bit., conc. lead covd .. ..
01	E. H. Wright ..	230	Direct ..	4 B. & W.	3 Alley and MacLellan	3 Lancashire D. & M. Co.	495	..	Hart, 420 amp.-hrs.	Triple conc. fdrs. and dist., solid .. ..
98	L. P. Greig ..	110 & 220	Direct ..	3 Penman dryback, 3 Paxman Economic ..	2 Paul, 2 Brush, 3 Belliss	2 Clark-Muirhead, 2 Brush, 3 Westinghouse	1,150	480.	Tudor, 1,200 amp.-hrs.; max. dis. 700 amps for ½ hour	Bare cpr. strip, armd. rubber laid direct h Henley, and Silvertown, and Callender solid
00	C. C. Atchison ..	220 & 440 D.C. 3,000 A.C.	50~, 3-ph., & direct	5 Lanc., stokers, cond., econ.	5 Belliss, 2 Browett-Lindley ..	1 E.C.C., 2 Siemens, 2 Johnson-Lundell, D.C.; 2 B.T.H., A.C.	1,976	391.5 lg. 517 tr.	Pritchetts & Gold, 600 amp.-hrs.	Glover diatrine and B.I. & H., ppr., lead co s and 3-core in pipes and ducts, dist. armd.
02	A. P. Lumsden ..	230	Direct ..	2 Marshall loco-type	2 Tangye	2 Silvertown	89	43.2	Hart, max. dis. 37 KW. ..	Silvertown vulc. rubber, laid solid ..
01	Edward Cross ..	230 & 440	Direct ..	7 Lancashire	8 Allen	7 Allen, 1 Siemens	1,208	751	E.P.S., 57 KW. for 5 hours ..	Callender, conc., v. bit, and Glover diatrine
99	E. B. Stiven ..	230 & 460	Direct ..	2 Lancashire	2 Alley & MacLellan	2 Parker	84	24	.. ..	B.I. & H. lead covd. armd. direct, lead covd on pier
95	A. Jupp	100	Direct ..	1 Paxman	1 Blackstone	1 Flather, 1 Silvertown	43	..	.. ..	B.I. & H. ppr., lead covd. in pipes ..
03	H. Love	220 & 460	Direct ..	Gas plant	2 Campbell gas engines	2 Greenwood & Batley	160	100	E.P.S., 700 amp.-hours ..	B.I. & H., 3-core laid solid .. .. ..
03	T. S. Shenton ..	220	50~, 3-ph.	.. ..	3 Willans	2 B.T.H.	210	125	.. ..	Henley, paper lead covd., laid solid ..
96	A. E. Lee ..	100	100~, 1-ph.	Dowson gas plant, 1 vertical boiler ..	2 Crossley (gas)	2 Brush	85	62	.. ..	Glover ppr., lead covd., armd., laid direct
03	A. E. Mayes .. (Eng. & Man.)	240 & 480	Direct, & 50~, 1-ph.	2 Tangye gas producers, w. vert. boilers, clg. tr.	2 3-cyl. Tangye, vert. Reavell compr. for starting	2 Parker	122	83	D.P., max. dis. 144 KW. ..	Callender; fdrs. triple conc.; h.p. fdrs. co 3-core; lead covd. and armd., direct
01	J. H. Clothier ..	240	Direct ..	4 Dryback	5 Willans	2 Parker, 3 Dick Kerr	750	179 lg., 400 tr.	Tudor, 80 KW.	B.I. & H. and Callender, conc. fdrs., single in wood; paper ins., lead covd. bit. covd.
97	A. B. Child ..	110 & 220	Direct ..	2 Dowson suction gas producers	2 Premier gas	4 Mackie	80	..	Hart, max. dis. 30 KW. ..	Callender, 3-core, lead covd. .. ..
96	E. M. Hollingsworth	230	Direct ..	4 Lanc., 4 B. & W., cond., econ., Beaman & Deas 4-cell destructor	9 Willans	4 Mather & Platt, 2 Dick Kerr ..	1,240	1,007	Chloride, max. dis. 510 KW. ..	B.I. & H., and St. Helens, ppr., ld. covd. fdrs. s conc. solid, dist. single, solid conc. & single-a
98	C. J. Wood ..	230 & 460	Direct ..	Energy supplied in bulk by Trafford Power & Light Co., at 3,000 v., 3-ph., 50~.	4 British Schuckert Motor Generators	4 British Schuckert Motor Generators	100	48	Tudor, max. dis. 100 KW. ..	Paper, lead covd., laid solid in wood; B.I. & H Glover
95	C. D. Tate ..	220, 440 D.C.	75~, 1-ph.,	16 Lanc., stokers, cond., econ.	8 Browett-Lindley, 1 Mather &	9 Mather & Platt	6,590	3,600	Tudor, max. dis. 270 KW. ..	Glover, D.C., lead covd. ppr. single, fdrs. in solid, A.C., lead covd. ppr. conc. in e.-ware

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ins.	Total capital expended.	Private lighting, eqvt. 8 c.p. lamps.	Public lighting.	No. and H.P. of private motors.	No. and H.P. of traction motors.	Total connections of all kinds, eqvt. 8 c.p. lamps.	Percentage increase during year.	Price charged per unit, pence.	System of charging.	Units sold during last complete year.	Pence Per Unit Sold. Av. price obtained.	Working costs.	Total costs.	Remarks.	
l. direct	£7,000	..	96 inc. ..	..	..	..	..	Lg. 6, pb. lg. 3, pr. 3 ..	Flat rate ..	..	..	..	..	.. ..	191
.I. & Helsby 2-core, armd.	..	..	..	..	..	..	..	Lg. 6, pr. 6 to 3½	Flat rate and scale	120,600	..	..	..	.. ..	192
H., triple conc. fdrs., 3-core	£39,977	24,711	48 arc, 8 inc.	24=86 H.P.	..	27,595	8.6	Lg. 7 & 2½, or 5½, pr. 2, pb. lg. 1.5	Max. dem., flat & contract	360,111	4.25	1.62	2.25	Max. load in summer	193
eet ead covd., conc., fdrs. in	£48,436	6,397	136 arc ..	24=112 H.P.	..	15,850	..	Lg. 6 & 3, pr. 2 to 1½, pb. lg. £18.9 arc, £2.925 inc.	Max. demand & flat rate	334,017	3.25	1.98	2.58	Private supply started Sept., 1901 ..	194
triple conc., solid; dist.,	£20,454	9,672	15 double inc. 2 arc., 174 inc., 65 Nernst	46=103 H.P.	..	16,194	45	Lg. 4, pr. 2½ to 1, pb. lg. 2	Flat rate & scale	335,636	2.35	0.87	1.32	Results for Jan. 8, '03, to Mar. 31, '04..	195
lid	£21,346	5,519	..	34 H.P. ..	..	6,462	20	Lg. 8 & 2, pr. 2½, tr. 1¾ ..	Max. demand & flat rate	72,885	4.3	1.5	2.2	Lg. & tr.	196
core dist., conc. feeders ..	£26,000	..	..	9=91 H P...	..	5,160	..	Lg. 5, pb. lg. 2½, pr. 1⅜—2½	Flat rate and sliding scale	..	..	..	..	.. ..	197
fdrs. armd. direct, dist. v.	£65,000	25,424	72 arc, 201 inc. 38 Nernst.	4=160 H.P.	40=1,000 H.P.	58,372	..	Lg. 5½, pr. 2½, pb. lg. 3, tr. 2½	Flat rate and contract	798,106	3.37	1.06	2.31	Lg. & tr.	198
ist.; fdrs. conc. & single	£32,607	14,032	10 arc, 24 inc. 3 Nernst	76=323 H.P.	..	23,555	58	Lg. 6 & 3, or 4½, pr. 2, 1½ & 1½, pb. lg. 2	Max. dem., flat rate & scale	274,521	3.2	0.93	1.41	.. ..	199
3-core dist., all armd. ..	£33,328	10,400	2 arc, 64 inc., 45 Nernst.	15=55½ H.P.	..	11,950	43	Lg. 7 & 4, or 6, pr. 4 & 1½, or 2½, pb. lg. £2.75 p.a.	Max. demand & flat rate	83,974	4.84	..	..	.. ..	200
drs. 2-core, dist. single ..	£8,000	2,974	1 arc, 86 inc.	..	..	3,249	22	Lg. 5, pb. lg. £3 p.a. ..	Flat rate & contract	100,578	..	..	..	.. ..	201
rmd...	..	2,009	87 inc. ..	..	..	2,827	..	Lg. 4½, or 1s. per c.p.p.a., pb. lg. contract	Flat rate & contract	..	..	..	..	.. ..	202
n trough	£50,000	20,000	46 arc, 180 Nernst	235 H.P. ..	..	27,180	..	Lg. 7 & 2*, pb. lg. 1.75, tr. 2 to 1½, pr. 2 to 1	Max. demand, flat, & scale	493,400	3.25	1.636	2.496	Supply to tramways later. * Shop lg., 5; house, 4d. per unit	203
.. ..	..	..	..	5=22½ H.P.	..	..	..	Lg. 5½ to 4, pr. 2½ to 1½..	Sliding scale	..	..	..	..	*C. S. Vesey-Brown, Cons.	204
covd. and armd., direct..	£17,000	3,469	..	4=2½ H.P....	..	3,552	112	Lg. 6 & 4*, pr. 3	Special scale & flat rate	35,097	5.108	..	..	*Lg. 6d. first 2½ units per 8-C.P. per qr.; all above, 4d.	205
llender, B.I. & H., Glover, son & Phillips	£2,190,690	458,442	58 arc ..	1,917=9,395 H.P.	*	735,382	21	Lg. 5½ & 1½, pr. 1½—1, pb. lg. 2, tr. 1.49	Max. demand & sliding scale	33,686,710	2.14	.75	1.06	*Corporation tramways supplied from Dickinson St., Bloom St., and Stuart St. Works. Plant installed for 800 cars.	206
ppr. lead covd., laid solid	£65,000	8,760	40 arc, 12 Nernst	33=83 H.P.	..	12,250	29	Lg. 7 & 1, pr. 4 & 1, pb. lg. 2	Max. demand & 2-rate mtr.	194,000*	3.7*	1.1*	1.94*	Lg. and tr. * Approx. (June 7th, 1905) 3 geng. sets being instd., tr. just comcng.	207
.. ..	..	10,000	20 arc ..	..	120=3,000 H.P.	..	..	Lg. 5, pr. 3, pb. lg. 2½ ..	Flat rate & sl. scale	..	4	..	..	Lg. & tr.	208
bit. fibre, ld. covd. armd.; rmd., direct	£14,698	5,376	..	20=73 H.P.	..	7,575	..	Lg. 7 & 4., pr. 2½ ..	Max. demand & flat rate	46,998	4.9	1.3	2.1	. .. .	209
d solid	..	..	..	..	..	1,036*	..	Lg. 6, pb. lg. & pr. 3 ..	Sliding scale	..	..	..	..	*June, 1904	210
ped, triple conc. fdrs., 3-	£37,673	9,824	8 arc, 126 inc., 7 Nernst	30=102 H.P.	..	13,543	23	Lg. 7 & 4, or 6, pr. 4 & 1½, or 2½*	Max. dem., flat rate, & cont.	176,840	3.4	1.64	2.16	*Pb. lg. 5 years at £325 p.a.	211
fdrs. lead covd. in C. I. nc. & 3-core	£37,793	6,065	12 arc ..	9=23 H.P....	30=900 H.P.	31,307	5	Lg. 7 & 2*, pr. 4½ & 1½, tr. 1½.	Max. demand	643,251	1.95	1.02	1.42	Lg. and tr. * Max. average, 4½d. ..	212
.. ..	£1,132	..	38 inc.	..	..	..	..	Lg. 7½	Flat rate and contract	..	..	..	..	.. ..	213
.. ..	£18,572	7,215	15 arc, 226 inc..	5=35 H.P....	..	9,356	14	Lg. 4½, pb. lg. 2.08, pr. 2½ & 2	1st rate ..	279,093	2.64	.74	1.08	.. ..	214
.. ..	£87,000	49,315	..	87=914 H.P.	..	72,045	41	Lg. 6 & 2, or 4, pr. 2 & 1	Max. demand & flat rate	906,809	2.98	.89	1.36	Motors on hire-purchase system ..	215
r lead covd. triple conc.	£38,000	5,304	9 arc ..	19 = 42 H.P.	..	6,304 (ex. tr.)	..	Lg. 4 & 3, pr. 2 to 1½, pb. lg. 3, tr. 1½ to 1	Flat rate & sl. scale	911,737	1.58	.6	.81	Local Traction Co. & Manchester Corp. supplied; 814,854 units sold during year ended 31st March, 1905	216
vd., armd., and St. Helens	£4,700	2,720	..	5=24 H.P....	..	3,200	100	Lg. 6, pr. 2	Flat rate ..	24,692	5.14	2.281	2.684	Data to Dec. 31st, 1904. 80 H.P. suction gas plant and engine being installed	217
d covd. and armd. ..	£17,955	4,120	2 arc, 120 inc.	6=14 H.P....	2=20 H.P. (pumping)	5,428	5.5	Lg. 5½, pr. 3, pb. lg. £425 p.a.	Flat rate ..	106,187	3.21	1.14	2.07	Very dry year necessitated the use of steam on 344 days (previous year 19 days)	218
drs., 3-core dist. ..	£37,445	8,575	20 arc; inc. & St.=461 8-CP.	46=157 H.P.	..	15,130	30	Lg. 6 & 4, or 5½, pr. 4 & 1½, or 2½*	Max. dem., flat rate & contract	149,479	3.73	1.4	1.99	*Pb. lg. £10 per arc per 1,000 hrs., inc. £1, Nernst, 25/- per 1,000 hr. ½, 50/- ½	219
umen casing	£62,489	11,480	104 arc, 278 inc.	11=71 H.P....	..	16,259	..	Lg. 5, pr. 3..	Flat rate ..	207,598	..	2.62	3.31	.. ..	220
.. ..	£27,500	12,057	15 arc, 2 Nernst	8=9½ H.P..	..	12,571	17½	Lg. 4 w. dis., pb. lg. £22, pr. 2	Flat rate with discount	142,956	3.4	1.15	1.79	Four months' free supply given to 32 new consumers included	221
.. ..	..	4,100	..	10=35 H.P.	..	5,276	..	Lg. 5½, pr. 2½ to 1½ ..	Sliding scale	..	..	..	..	.. ..	222
le conc., direct inground	£62,233	22,428	60 arc, 560 inc., 62 Nernst	123=939 H.P.	..	45,414	28	Lg. 3½, pr. 2 to 1, pb. lg. arc £18, inc. 56/-	Flat rate & sliding scale	730,177	2.27	.57	.82	Station claims lowest costs for a lighting and power load only	223
paper, laid solid	£90,000	3,000	20 arc ..	10=66½ H.P.	20=500 H.P.	19,112	..	Lg. 5, pr. 3 & 1½, pb. lg. £18 avge.	Flat rate & max. demand	..	..	..	..	Lg. & tr.	224
.. ..	£59,000	19,816	12 arc, 24 inc.	170 H.P. ..	18=450 H.P.	34,228	12	Lg. 4 to 3, pr. 2½ to 1½, tr. 2	Sliding scale	690,044	2.846	.959	1.339	Lighting and traction	225
nd.; triple conc. fdrs., 3	£40,000	4,150	..	12=564 H.P.	..	5,500	..	Lg. 7 & 3, or 6, pr. 2½ & 1	Max. demand and flat rate	..	..	..	..	Supply commenced June 1, 1905 ..	226
v.r. in troughing, D.C. ..	£405,430	..	..	..	..	130,253	18	Lg. 4½ to 1, pr. 2½ to 1 ..	Max demand, flat, & contract	3,259,389	2.18	..	1.15	.. ..	227
p, fdrs. 3-core lead covd.. ron troughs; dists., v. bit.. re troughs.	£1,147,405	184,000	1,000 eq. 8-c.p.	665,000 equiv. 8-c.p.		850,000	Over 120	Lg. 4½ & 1, pr. 1½, tr. 1½	Max. demand & sl. scale	17,132,153	1.30	35	.67	Lg. & tr. See also under "Power Distribution Companies" on other Table	228
id solid, dist. lead covd.	£6,000	2,968	..	..	..	2,968	..	Lg. 6, pr. 3	Flat rate ..	27,802	6	1.37	3.24	.. ..	229
st. 3-core, all lead covd..	£36,378	9,591	12 arc ..	2=5½ H.P....	..	16,721	23	Lg. 7 & 4, pr. 4 & 1½ ..	Max. demand	121,005	6.017	1.45	2.17	Data to Dec. 31st, 1903	230
dist. 3-core, lead covd.. o Cowes, 3 single v. bit.	£77,408	..	30 arc, 60 inc., 5 Nernst	30=97 H.P....	..	24,035	36	Lg. 7 & 4, or 6, pr. 4 & 1½, or 2½	Max. demand & flat rate	232,419	4.2	1.39	2.1	H.T. substation in E Cowes. Supply from N. to C. at 2,500 volts D.C.	231
.. ..	£103,000	44,017	76 arc, 6 inc.	16=60 H.P....	..	45,650	..	Lg. 5½ to 3, pr. 2 to 1 ..	Sliding scale	1,572,362	2.77	1.10	1.31	.. ..	232
lid	£32,588	3,544	144 Nernst..	8=37 H.P....	..	4,511	..	Lg. 7 & 3, or 6, pr. 4 & 1½, or 2½	Max. demand & flat rate	29,015		2.8	3.9	Data for 1903-4	233
bit. solid; dist. v. bit.. luminium overhead uiverts; Callender and laid solid	£9,733	2,846	31 arc; 81 inc.	23=56 H.P....	..	5,594	..	Lg. 6, pr. 4 to 2* ..	Flat with disc., scale & cont.	70,159	4.0	2.39	3.57	*Pb. lg., arc 13/-, inc. 3/9 & 3/-, per 100 hrs. Data to 31st December, 1904	234
	£100,005	36,885	..	351 H.P. ..	..	47,430	16	Lg. 6 & 3, priv. houses 4½, pr. 2 with dis.	Max. demand, flat rate & disc.	569,671	3.75	1.00	1.58	.. ..	235
. & triple conc., paper,	£29,222	11,600	59 inc. ...	36=227 H.P.	..	18,123	23	Lg. 6 & 4, pb. lg. 2½, pr. 2 and 1	Max. demand	195,485	3.53	1.605	2.557	A. W. Selater, Cons. Eng. *Station run by Mond Gas from Chemical Works	236
.. ..	£236,701*	102,000	16 arc 9 Nernst	260=1,104 H.P.	..	134,709	9	Lg. 4½, pb. lg. 1, pr. 3 to 1	Flat rate & scale	2,097,902	3.46	1.08	1.56	Purchased from Norwich Electy. Co., Ltd., in 1902. *Including purchase	237
lid	£417,272	214,734	160 arc. ..	374=2,014 H.P.	..	267,401 ex. tr.	..	Lg. 5 & 1½, pb. lg. 5 & 1½, pr. 1½, tr. 1½.	Max. demand & flat rate	8,469,921	2.07	.75	1.06	Lighting and traction	238
cts; dist. armd. direct; er and St. Helens	£23,000	12,331	20 arc, 115 Nernst.	23=111 KW.	..	16,693	..	Lg. 6 & 3, or 5, pr. 3 & 1½, or 2½	Max. demand flat rate & scale	196,028	4.27*	1.554*	2.210*	*Data for 1904	239
conc. fdrs. armd. direct,	£8,878	3,100	203 inc. ...	..	..	3,500	4	Lg. 4, 4½ & 6, pb. lg. contract	Sliding scale & contract	..	..	..	..	.. ..	240
and v.r. in pipes, solid,	£216,882		..	..	..	54,154	..	Lg. 4 & 1½ pr. 2 to 1½, tr. 1½, pb. lg. 2½	Max. demand flat scale	2,869,312	2.53	0.95	1.13	Lg. & tr. Data to March, 1903.. ..	241
.. ..	£10,578	5,200	..	3=12 H.P. ..	..	..	6	Lg 7 & 3, pr. 3*	Max. demand & flat rate	96,852	6.2	3.2	4.1	* Minimum of 10s. per H.P. installed ..	242
.. ..	£2,000	1,014	22 inc. ..	1=5 H.P. ..	..	1,192	18.2	Lg. 6½, pb. lg. 4, pr. 3 ..	Flat rate with rebate	12,580	5.9	4½	5.1	Public lighting experimental	243
diatrine, Callender l.p.	£145,401	60,934	32 arc, 48 inc.	42=130 H.P.	..	65,276	17	Lg. 6, pr. 3½, pb. lg. 2.3	Flat rate with discount	847,136	5.16	1.67	2.44	Data to December 31st, 1904	244
nc. armd. dist.	£149,000	49,950	91 arc* ..	18=222 H.P.	100=2,500 H.P.	56,166	8.5	Lg. 4, pr. 2½, pb. lg. £25, tr. 2 to 1½	Flat rate & scale	1,757,800	3.8†	1.48†	..	Lg. & tr. *With rectifiers. †For 1904. Returns for 1905 not available	245
triple conc. lead covd.	£78,155	34,437	238 arc, 69 Nernst	109=879 H.P.	..	64,709	63.2	Lg. 3½, pr. 1, pb. lg. .9d.	Flat rate ..	1,320,348	1.72	0.65	0.90	Extensions in hand	246
covd. ppr. in C.I. pipes,	£30,000	2,050	18 arc, 800 inc.	6=20 H.P. ..	..	9,500	50	Lg., priv. & pb., 3, pr. 1½d.	Flat rate and contract	193,687	1.75	1.03	1.4	.. ..	247
wood	£39,500	8,198	34 arc, 101 inc.	1=3 H.P. ..	..	9,103	24	Lg. 4½, pr. 3, pb. lg. contract	Flat rate and contract	180,309	3.76	..	2.53	.. ..	248
nc., dist. 3-core, solid in	..	2,391	6 arc ..	..	..	2,480	..	Lg. 7 & 3	Max. demand	..	..	..	..	.. ..	249
.. bit. dist. solid, armd. g.	..	23,651	70 arc, 59 inc.	140 H.P. ..	40=1,400 H.P.	29,076 ex. tr.	..	Lg. 4, pb. lg. 1½, pr. 2 ..	Flat rate ..	..	..	..	..	Tramways not yet running (June 1905)	250
solid in wood troughs, sing	£48,918	14,832	72 arc, 6 Nernst	23=54 H.P.	28=560 H.P.	31,668	..	Lg. 4½ & 4, pr. 1½, pb. lg. £12, tr. 2½ to 1½	Flat rate and scale	445,728	3.02	1.60	1.88	Lg. and tr.	251
and Callender.. ..	£126,000	80,600	73 arc ..	..	78=1,700 H.P.	74,200	..	Lg. 4½, pr. 3, tr. 2.5 ..	Flat rate ..	1,279,743	3.38	1.32	1.61	Lighting and traction	252
nd..	£11,412	6,612	6 arc, 1 Nernst	7=11 H.P....	..	7,015	10	Lg. 6, pb. lg. 4*, pr. 3 ..	Flat rate ..	76,826	5.71	1.82	2.52	* Inc. hire & maintenance. Cost of extensions charged to works costs	253
.. ..	£55,000	..	40 arc ..	10 H.P. ..	24=888 H.P.	..	..	Lg. & pr. 6 & 1½, pb. lg. & tr. 1½	2-rate meter	..	..	..	..	Tr. supply commenced Mar. 6/05. Lg. May 1/05. 230 cons. awaiting connec.	254
.. ..	..	149,840	264 arc, 146 inc.	152=341 H.P.	..	163,980	..	Lg. 4½ pr. 1½, pb. lg. £18 & £3 3s.	Flat rate ..	2,717,310	..	..	..	.. ..	255
.. ..	£62,676	10,500	23 arc, 277 inc.	21=161 H.P.	8=200 H.P.	87,594	13	Lg. 4, pb. lg. 2, pr. 1, tr. 1 to ½	Flat rate ..	2,939,590	1.25	.42	.48	Supply to South Lanc. Tramways and B.I. & H.C. works	256
-conc.	£152,750	58,779	42 arc ..	..	..	59,410	..	Lg. 4 & 2, pr. 1½	Max. demand & sl. scale	..	..	..	..	.. ..	257
.. ..	£23,000	2,465	15	..	..	..	..	Lg. 8 & 3	Max. demand	..	..	..	..	.. ..	258
rs. (3 core) and tr. fdrs. d in Howard troughing	..	3,000	..	3=3 H.P. ..	..	..	..	Lg. 5, pr. 2, tr. 1½ ..	Sliding scale	..	..	..	..	Lg. & tr. Plant fully loaded for tr., 250-KW. set being installed	259
. triple conc. laid solid, direct	..	..	..	..	..	..	..	Lg. 7 & 3, pr 2	Max. demand & flat rate	..	..	..	..	.. ..	260
le conc.	£88,712	22,094	108 arc, 418 inc.	3=9 H.P. ..	..	22,319	8.4	Lg. 4½, pr. 2 & 1½, pb. lg. £18 & £8½	Flat rate ..	547,780	Priv. 4.43 Pub. 2.62	1.13	1.66	.. ..	261
armd., also Simplified em	£181,237	60,000	..	220=1,008 H.P.	..	90,000 approx.	28	Lg. 6 to 3, pr. 3 to 1½ ..	Sliding scale	1,018,000	3.78	1.03	1.62	.. ..	262
lead covd., armd. ..	£21,584	8,778	311 inc.	26=165 H.P.	..	15,844	..	Lg. 5½ & 5, pr. 1½ & 1, pb. lg. £3	Flat rate or 2-rate meter	265,717	2.64	1.88	2.22	.. ..	263
.. ..	£30,000	12,200	4 inc. (7 amp.)	3=14 H.P....	..	12,600	..	Lg. 7 & 4, pr. 3	Max. demand and flat rate	..	..	..	..	.. ..	264
d	£22,893	2,100	58 arc ..	3	..	3 045	..	Lg. 6 & 3, or 4½	Max. demand and flat rate	..	..	..	..	.. ..	265
la d direct by Glover, Callender solid system	£83,080	42,023 inc. hgs.	..	23=141 H.P.	..	43,906	20	Lg. 6, pr. 2½	Flat rate ..	473,771	..	1.219	1.618	.. ..	266
, ppr., lead covd., fdrs. ts, dist. armd. direct lid.	£63,414	23,710	..	Appx. 50=376 H.P.	102=3,502 H.P.	28,852 exc. tr.	8.40	Lg. 6 & 2, or 4½, pr. 2 to 1, tr. 1½ to 1	Max. demand flat rate & sc.	1,160,593	1.98	.708	1.029	Lg. and tr.	267
	£5,255	1,500	36 Nernst ..	3=7 H.P. ..	..	2,622	25	Lg. 7, pb. lg. £½, pr. 3 ..	Flat rate .	26,808	6.11	3.41	5.26	.. ..	268
over diatrine	£47,905	17,200	..	29=80 H.P.	60=1,500 H.P.	54,111	5.2	Lg. 4½ to 4, pr. 1½ to 1, tr. 1½	Flat rate ..	1,227,007	2.02	0.50	0.80	Lg. and traction.	269
rect, lead covd. in pipes	£3,000	56	35 arc, 22 inc.	..	..	..	..	..	..	..	..	..	..	.. ..	270
pes	..	1,000	14 inc. ..	1 H.P. ..	..	1,050	..	Lg. 6	Flat rate ..	..		..	..	.. ..	271
.. ..	£19,000	4,960	70 Nernst ..	..	..	5,200	41	Lg. 6, pb. lg. 4, pr. 3 ..	Flat rate and sliding scale	99,920	..	..	..	.. ..	272
olid	£12,000	8,052	..	11=18½ H.P.	..	8,092	50	Lg. 5½, pr. 2½ & 3 ..	Flat rate ..	88,497	5	..	3.09	Supply from the B.T.H. Co.'s works at 2,000 volts	273
laid direct	£4,500	5,000	..	..	..	5,000	..	Lg. 4 & fixed charge, small houses 5	Hopkinson	43,000	..	..	..	.. ..	274
; h.p. fdrs. conc.; dist. , direct	£54,530	8,905	50 inc. ..	22 H.P. ..	..	9,945	97	Lg. 7 & 4, or 6, pr. 4 & 1½, or 2½	Max. demand & flat rate	78,505	4.95	3.1	5.1	*Combined with St. H. E. Ltg. Co. 2500 v. for part of St. H. Pb. lg. £2.5 & £2.7	275
fdrs., single dist., solid z. bit. covd.	£30,005	15,005	34 arc, 58 inc., 109 Nernst	12=30 H.P.	..	22,694	..	Lg. 7 & 2, or 5½, pb. lg. & pr. 2½, tr. 2 to 1½	Max. demand & flat rate	589,500	3.6	1.18	1.55	*Energy sold to Tramway Co., max. demand limited to 300 KW.	276
.. ..	£6,000	2,000	..	14 H.P. ..	..	2,350	..	Lg. 5, pr. 2	Flat	..	..	..	..	New station being erected	277
d covd. fdrs. single & tri. nc. & single armd. direct	£127,956	24,406	35 arc, 70 inc.	160=954 H.P.	..	54,043	20.8	Lg. 4½, pr. 2 & 1, pb. lg. £15, tr. 1.11 & .37	Lg. flat, pr. m.d., tr. scale	2,089,744	1.86	.554	.78	Lighting and traction. Extensions in hand, 500 KW. Willans-Dick Kerr set	278
wood; B.I. & Helsby and	£9,000	5,982	2 arc, 9 inc., 6 Nernst	1=2 H.P. ..	..	5,307	31	Lg. 6 & 3, pr. 3 & 1½, pb. lg. 2½	Max. demand & flat rate	41,280	4.66	2.06	3.1	.. ..	279
gle, fdrs. in ducts, dist. nc. in e.-ware pipes	£545,897	125,634	116 arc ..	270=2,980 H.P.	402=11,080 H.P.	444,342	23.4	Lg. 3½*, pb. lg. 1.22, pr. 2 to 1, tr. 1.5	Flat rate & sliding scale	9,002,310	1.732	.40	.63	Lighting and traction. *Alternative, 1s. per 8-C.P. per qr. & 1½d. per unit	280
	£61,205	20,462	35 inc. ..	36=182 H.P.	..	23,888	..	Lg. 7, 4 & 2, pr. 4 & 1½ ..	Max. demand	397,611	3.63	1.08	1.46	.. ..	281

237 NORWICH	Corporation	1896	F. M. Long	220 & 440	Direct	7 B. & W., 4 dryback, econ.	6 Willans, 1 Parsons turbine	3 Laurence-Scott, 3 Siemens	2,994
238 NOTTINGHAM	Corporation	1894	H. Talbot	200 & 400	Direct	16 Lanc., 14 dryback, econ., feed. htr., 6 B. & W. with 12-cell Manlove dest.	32 Willans	32 Siemens	8,728
239 NUNEATON	Urban District Council	1900	S. C. Gibson	220 & 440	Direct	3 B. & W., economiser, cond.	2 Willans, 1 Paxman	1 Johnson & Phillips, 1 Siemens, 1 E.C.C.	375
240 OGMORE VALLEY	Ogmore Valley E. L. & P. Supply Co.	1891	T. Thomas	100 to 220	40–, 1-ph., & direct	2 B. & W.	1 Robey, 2 Paxman	2 Parker, D.C.; 2 Siemens A.C.	150
241 OLDHAM	Corporation	1894	S. W. Newington	210 & 420	Direct	8 Lanc., 8 Marine, 3 Climax, cond., 8 destructor cells	16 Willans, 1 Parsons turbine	4 Hall, 12 Siemens, 1 Parsons	5,232
242 OSWESTRY	Oswestry Elec. Light & Power Co.	1893	E. B. Smith	220	Direct	2 loco., 2 B. & W., ch. gr. stoker	2 Marshall, 2 Belliss, 1 Scott & Mountain	2 Parker, 1 Siemens, 1 Scott & Mountain, 1 McClure	253
243 OULTON BROAD	Oulton Broad Electricity Co.	1902	B. Barber	230	Direct	1 loco., 1 Cornish	1 Paxman, 1 Hornsby	1 Laurence Scott, 1 Harrison Engineering Co.	34
244 OXFORD	Oxford Electric Co.	1892	F. H. Francis	100	Direct	5 loco., 2 Economic; cond.	5 McLaren, 1 Willans, 1 Belliss	7 Electric Construction Co.	1,200
245 PAISLEY	Corporation	1899	C. F. Parkinson	200 A.C. 500 D.C. (tr.)	50–, 1-ph. & direct	8 B. & W., stokers	1 Adamson, 2 Ferranti, 2 Peache, 2 Davey Paxman	2 Ferranti, 2 Schuckert, A.C.; 1 Schuckert, 2 Bruce Peebles, D.C.	1,300 (lg.) 1,800 (r.)
246 PARTICK	Corporation	1902	H. B. Maxwell	240 & 480	Direct	4 B. & W., 1 Stirling, econ., Manlove Alliott 6-cell dest.	5 Belliss	4 Peebles, 2 Greenwood & Batley	1,050
247 PEMBERTON	Urban District Council	1902	J. Slevin	230 & 460	Direct	3 Lanc., cond., clg. tr.	4 Belliss	2 Mather & Platt, 2 Dick Kerr	1,000
248 PEMBROKE (DUBLIN)	Urban District Council	1900	S. L. R. Price	220 & 440	Direct	3 Lanc., 1 B. & W., stokers, econ., cond.	2 Easton	4 Easton	300
249 PENARTH	Penarth Electric Lighting Co.	1901	S. G. Leech	230 & 460	Direct	2 B. & W., feed htr.	2 Brush Universal	2 Brush	100
250 PERTH	Corporation	1901	J. Lambert	230 & 460	Direct	4 B. & W., cond., econ.	4 Willans, 1 Brush	3 Peebles, 2 Brit. Elec. Plant Co.	1,175
251 PETERBOROUGH	Corporation	1900	J. C. Gill	200 & 400	Direct	4 Lanc., cond., econ.	5 Willans, 1 Belliss	2 G.E.Co., 1 Peebles, 3 Crompton	840
252 PLYMOUTH	Corporation	1899	E. G. Okell	100 & 200	50–, 1-ph., D.C. for tr.	9 Lanc., stokers, econ., cond.	5 Belliss, 2 Ferranti	6 Ferranti, 3 Westinghouse	2,300
253 PONTYPOOL	Pontypool Elec. Light & Power Co.	1893	..	103	Direct	3 loco., feed htr.	4 Willans	3 Crompton, 1 Parker	169
254 PONTYPRIDD	Urban District Council	1904	J. E. Teasdel	220 & 440	Direct	3 B. & W., econ., Heenan 3-cell dest.	3 Combe-Barbour	3 Greenwood & Batley	600
255 PORTSMOUTH	Corporation	1894	W. S. Foale	100	50–, 1-ph.	18 Lanc., stokers, econ., cond.	5 Yates & Thom, 3 Parsons turbines	4 Ferranti, 1 Brown-Boveri, 3 Parsons	3,336
256 PRESCOT DISTRICT	British Insulated & Helsby Cables	1891	R. P. Nash	100 A.C., 250 & 550 D.C.	100–, 1 ph. & direct	5 Lanc., stokers, suphtrs., econ., cond., clg. tr.	3 Browett-Lindley, 1 Alley and MacLellan, 1 Ferranti, 1 Willans	1 English Electric, 1 Peebles, 1 Silvertown, 3 Johnson & Phillips	1,460
257 PRESTON	National Electric Supply Co.	1892	J. H. Tonge	250	50–, 1-ph., & direct	6 Lanc., 3 dryback	5 Belliss, 3 Willans	2 Clark-Muirhead, 2 Siemens, 2 E.C.C. direct, 2 E.C.C. altg.	1,970
258 QUEENSTOWN	Cork Elec. Trwys. and Lighting Co.	1900	W. H. Joyce	230 & 460	Direct	2 B. & W.	2 Belliss	2 B.T.H.	100
259 RADCLIFFE	Urban District Council	1904	M. B. Henry	220	Direct	2 Lanc.	2 Browett-Lindley	2 Mather & Platt	240
260 RAMSGATE	Ramsgate & Dist. Elec. Supply Co.	1905	M. Farrer	240 & 480	Direct	2 Hornsby	2 Belliss	2 Parker	250
261 RATHMINES	Urban District Council	1900	G. F. Pilditch	230 & 440	Direct	3 Lanc., stokers, econ., Heenan & Froude 6-cell dest.	3 Willans	4 Mather & Platt, 2 Dick Kerr.	750
262 READING	Reading Electric Supply Co.	1895	A. T. Cooper	200 A.C., 200 & 400 D.C.	67–, 1-ph. & direct	4 Lanc., 2 B. & W., econ., suphtrs.	3 Fowler, 5 Belliss, 2 Willans (gas)	3 Fowler, A.C., 8 E.C.C. and 5 Siemens D.C.	2,675
263 REDDITCH	Urban District Council	1899	W. J. Ferguson	200	66–, 1-ph.	Dowson gas plant	3 Premier, 1 Willans, gas engines	3 Johnson & Phillips, 1 E.C.C.	435
264 REICATE	Corporation	1901	W. S. Ross	200	50–, 1-ph.	2 B. & W., suphtrs., econ., detartariser	3 Allen	3 E.C.C.	230
265 RHYL	Urban District Council	1901	E. H. Wright	230	Direct	4 B. & W.	3 Alley and MacLellan	3 Lancashire D. & M. Co.	495
266 RICHMOND (SURREY)	Richmond (Surrey) E. L. & P. Co.	1893	L. P. Greig	110 & 220	Direct	3 Penman dryback, 3 Paxman Economic	2 Paul, 2 Brush, 3 Belliss	2 Clark-Muirhead, 2 Brush, 3 Westinghouse	1,150
267 ROCHDALE	Corporation	1900	C. C. Atchison	220 & 440 D.C. 3,000 A.C.	50–, 3-ph., & direct	5 Lanc., stokers, cond., econ.	5 Belliss, 2 Browett-Lindley	1 E.C.C., 2 Siemens, 2 Johnson-Lundell, D.C.; 2 B.T H., A.C.	1,976
268 ROSS	Ross Electric Light and Power Co.	1902	A. P. Lumsden	230	Direct	2 Marshall loco-type	2 Tangye	2 Silvertown	80
269 ROTHERHAM	Corporation	1901	Edward Cross	230 & 460	Direct	7 Lancashire	8 Allen	7 Allen, 1 Siemens	1,208
270 ROTHESAY	Corporation	1899	E. B. Stiven	230 & 460	Direct	2 Lancashire	2 Alley & MacLellan	2 Parker	34
271 ROTTINGDEAN	New Rottingdean Electricity Co.	1895	A. Jupp	100	Direct	1 Paxman	1 Browett-Lindley, 1 Belliss	1 Flather, 1 Silvertown	43
272 ROUNDHAY	Roundhay & Dist. Elec. Light Co.	1903	H. Love	230 & 460	Direct	Gas plant	2 Campbell gas engines	2 Greenwood & Batley	160
273 RUGBY	Urban District Council	1903	T. S. Shenton	220	50–, 3-ph.		2 Willans	2 B.T.H.	210
274 RUGBY SCHOOL	Rugby School Electric Light Co.	1896	A. E. Lee	100	100–, 1-ph.	Dowson gas plant, 1 vertical boiler	2 Crossley (gas)	2 Brush	85
275 RYDE & ST. HELENS	Isle of Wight Elec. Lt. & Pr. Co.	1903	A. E. Mayes (Eng. & Man.)	240 & 480	Direct, & 50–, 1-ph.	2 Tangye gas producers, w. vert. boilers, clg. tr.	2 3-cyl. Tangye, vert. Reavell compr. for starting	2 Parker	192
276 ST. ANNES-ON-SEA	Urban District Council	1901	J. H. Clothier	240	Direct	4 Dryback	5 Willans	2 Parker, 3 Dick Kerr	750
277 ST. AUSTELL	St. Austell & Dist. El. Lt. & Pr. Co.	1887	A. B. Child	110 & 220	Direct	2 Dowson suction gas producers	2 Premier gas	4 Mackie	80
278 ST. HELENS	Corporation	1896	E.M.Hollingsworth	230	Direct	4 Lanc., 4 B. & W., cond., econ., Beaman & Deas 4-cell destructor	9 Willans	4 Mather & Platt, 2 Dick Kerr	1,340
279 SALE	Urban District Council	1903	C. J. Wood	230 & 460	Direct	Energy supplied in bulk by Trafford Power & Light Co., at 3,000 v., 3-ph., 30–.		4 British Schuckert Motor Generators	100
280 SALFORD	Corporation	1895	C. D. Taite	220, 440 D.C., 200 A.C.	75–, 1-ph., & direct	16 Lanc., stokers, cond., econ.	8 Browett-Lindley, 1 Mather & Platt	9 Mather & Platt	6,520
281 SALISBURY	Salisbury Elec. Light & Supply Co.	1898	A. B. Randall	210	Direct	4 B. & W., suphtrs., ch. gr. stokers, cond.	4 Belliss, 1 Gilkes turbine (water)	4 Parker, 1 Parker generator-balancer and boosters=4 machines	600
282 SALTBURN	Cleveland Trust	1899	P. E. A. Warren	220	Direct	1 Paxman loco.; 2 Dowson gas generators, with Cochran boiler	1 Belliss (steam), 1 National, 1 Crossley (gas)	1 International (dir. cpld.): 1 Bruce Peebles, 1 Newton Elec. Works belt driven)	170
283 SCARBOROUGH	Scarborough Electric Supply Co.	1893	F. G. Holden	100 & 200 A.C., 500 D.C.	80–, 1-ph., & direct	5 Lanc. (4 Meldrum furnaces, 1 Crosthwaite), econ.	7 Parsons turbines	7 Parsons (5 A.C., 2 D.C.)	1,945
284 SHANKLIN, SANDOWN & LAKE	Isle of Wight Elec. Lt. and Pr. Co.	1901	A. E. Mayes (Eng. & Man.) C. H. Finnis (Asst.)	240 & 480	Direct	3 B. & W.	3 Peache	3 Parker	425
285 SHEERNESS	Sheerness & Dist. El. Pr. & Tr. Co.	1903	H. J. Nisbet	230 & 460	Direct	3 B. & W., suphtrs., cond., clg. trs.	3 Browett-Lindley	3 Brush	330
286 SHEFFIELD	Corporation	1894	S. E. Fedden	200	50–, 2-ph.	(5 B. & W., 8 marine, stokers, econ. (Sheaf St.). 2 Stirling (Neepsend)	1 Ferranti, 4 McLaren, 2 Parsons, 1 Browett-Lindley 2 Parsons (Neepsend)	3 Ferranti, 2 Parsons, 2 E. C. C., 1 Brush 2 Parsons	7,500
287 SHIPLEY	Urban District Council	1901	S. D. Schofield	230, 460 & 500	Direct	4 Lanc., econ., suphtrs., Meldrum 4-cell dest.	4 Parsons turbines	4 Parsons	1,170
288 SHREWSBURY	Corporation	1896	C. M. Johnston	210 & 420	Direct	3 Lanc., 4 B. & W., econ.	6 Belliss	6 Parker	540
289 SLEAFORD	Urban District Council	1902	R. G. S. Yates	220	Direct	2 Robey loco., 1 B. & W.	2 Willans, 1 Belliss	2 Laurence Scott, 1 Parker	180
290 SLOUGH & DATCHET	Slough & Datchet Elec. Supply Co.	1903	A. E. Farrow	220 & 440	Direct	2 Paxman econ., Paxman superheater	3 Davey Paxman	5 Siemens	580
291 SMETHWICK	Birmingham & Midland Tramways Joint Committee	1904	S. A. Mahood	250 & 500 D.C. 5,500 A.C.	25–, 3-ph., & direct	5 B. & W., stokers, econ., purifier	6 Brush	3 B.T.H., A.C.; 3 Brush, D.C.	2,400
292 SOUTHAMPTON	Corporation	1891	H. F. Street	200	Direct	3 Lanc., 8 B. & W.	5 Willans, 2 Ferranti, 1 Belliss, 2 Pollit & Wigzell (horizontal)	6 Crompton, 2 Schuckert, 2 Dick Kerr	2,200
293 SOUTHEND-ON-SEA	Corporation	1902	R. Birkett	230 & 460	Direct	3 Davey Paxman Economic, 2 B. & W., 2 Stirling, suphtrs., ch. grate stokers	3 Willans, 2 Bow Maclachlan, Howden	2 Crompton, 1 E. C. 1 Bruce Peebles, 2 Bow Maclachlan	1,475
294 SOUTHPORT	Corporation	1894	R. S. Downe	100 & 210 A.C., 500 D.C.	50–, 1-ph., & direct	9 Lanc., econ., suphtrs., cond.	4 Musgrave, 4 Belliss	5 Ferranti, 3 Bruce Peebles	2,350
295 SOUTH SHIELDS	Corporation	1897	J. H. Cawthra	110 & 220	50–, 1-ph.	5 Marine	6 McLaren	4 Ferranti, 1 Brown, 1 Siemens	1,600
345 WORKSOP	Urban District Council	1901	J. P. Crowther	230, 460 D.C. 220 & 440	& direct Direct	3 Lanc., cond., econ.	3 Scott & Mountain, 1 Belliss	Peebles, D.C. 3 Witting Bros., 1 Electrical Co.	500
346 WORTHING	Corporation	1901	G. Porter	230 & 460	Direct	3 dryback marine, econ., purifier, cond.	3 Scott & Mountain, 1 Allen	3 Scott & Mountain, 1 Mather & Platt	598
347 WREXHAM	Corporation	1901	W. Sillery	230 & 460	Direct	1 Lanc., 3 B. & W., stokers, feed htr. and softener, cond.; Meldrum dest., 4 cells.	4 Willans	4 Lancashire D. & M. Co.	675
348 YARMOUTH	Corporation	1901	G. Bryant	100 & 200	83–, 1 ph.	6 B & W., cond., econ.	7 Willans, 1 Peache	6 Crompton A.C., 4 do. series arc	735
349 YORK	Corporation	1900	C. A. Midgley	230 & 460	Direct	5 B. & W., 2 Lanc., stokers, econ., Manlove-Alliott 4-cell dest.	8 Willans	6 Crompton, 2 Dick Kerr	1,860

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350 BATTERSEA	Corporation	1901	W. Augustus Kemm	230 & 460	Direct	6 B. & W., stokers, cond.	5 Willans, 2 Parsons turbine	7 Mather & Platt, 2 Parsons	2,000
351 BERMONDSEY	Corporation	1902	W. E. J. Heenan	240	Direct	3 B. & W., econ., destructor	3 Willans	3 Thames Iron Works	375
352 CHELSEA	Chelsea Electricity Supply Co.	1889	Percy Still	200	Direct	21 B. & W.	21 Willans	21 E.C.C.	3,500
353 CITY OF LONDON	City of London Elec. Lighting Co.	1891	F. Bailey	204 & 410 D.C. 204 A.C.	Direct, & 100–, 1-ph.	46 B. & W., 13 Economic, stokers, cond.	2 Ferranti, 8 Brush, 12 Willans, 3 Allis, 4 Musgrave	2 Ferranti, 8 Brush, 13 Thomson-Houston, 7 Westinghouse	22,000
354 CITY OF LONDON	Charing Cross, West End & City Elec. Supply Co.	1899	W. H. Patchell	100, 200, & 400	Direct	14 Hornsby water tube	5 Sulzer, 2 Belliss	7 Lahmeyer	12,000
355 FINSBURY	County of London Elec. Supply Co.	1897	C. P. Sparks	104 A.C., 530 D.C.	50–, 2-ph. & direct	17 B. & W., ch. grate stokers, suphtrs., cond., econ.	9 Brush, 2 Allis, 2 Yates & Thom	3 Mordey, 6 E.C.C. A.C., 4 B.T.H. D.C.	4,350
356 FULHAM	Corporation	1901	Arthur J. Fuller	200	50–, 2-ph.	3 dryback, 6 B. & W., 2 Stirling, stokers, econ., cond.; Horsfall destructor, 12 cells	1 Belliss, 3 Musgrave	1 Dick Kerr, 3 G.E.Co., 1 Curtis turbine	2,250
357 GREENWICH LEWISHAM AND PENGE	South Metropolitan E.L. & P. Co.	1903	J.A.Constable (Nn.) W. J. Albright (Sn.)	200	50–, 2-ph.	6 B. & W.	Belliss	E.C.C.	3,100 (about)
358 HACKNEY	Corporation	1901	L. L. Robinson	240 & 480	Direct	9 B. & W., econ., cond., clg. tr., Hughes & Stirling 12-cell dest. w. motor driven forced draught	3 Belliss, 2 Willans	8 Johnson-Lundell (Holmes), 1 Brit. Westinghouse	3,372
359 HAMMERSMITH	Corporation	1897	G. G. Bell	110 & 220	50–, 1-ph.	6 Water-tube, 1 Lanc., cond.	3 McLaren, 1 Belliss, 3 Robey, 2 Musgrave	5 Ferranti, 2 E.C.C., 2 Siemens	2,500
360 HAMPSTEAD	Corporation	1894	G. H. Cottam	105 & 210	90–, 1-ph.	4 Lanc., 4 Marine (ind. draught), 14 Economic, cond., econ.	9 Willans, 2 Ferranti, 4 Belliss	10 Siemens, 4 Ferranti, 1 Parker	4,345
361 ISLINGTON	Corporation	1896	A. Gay	100, 200 & 400	50–, 1-ph.	8 Lanc., 10 B. & W., cond., stokers, suphtrs.	10 Adamson, 1 Scott-Reavell, Carliss	7 Ferranti, 3 Fowler, 1 Crompton	3,600
362 KENSINGTON	Brompton & Kensington Electricity Supply Co.	1889	H. W. Bowden	100	83–, 1-ph.	Stirling and B. & W.	Willans	E.C.C.	2,930
363 KENSINGTON AND KNIGHTSBRIDGE	Kensington & Knightsbridge Elec. Lighting Co.	1887	H. W. Miller	200	Direct	10 B. & W.	12 Willans	12 Siemens	5,800*
364 KENSINGTON AND NOTTING HILL	Joint Committee of K. & Knightsbridge & Notting Hill E. L. Cos.	1900	H. W. Miller, G. Schultz	00	45–, 3-ph.	8 B. & W., stokers, econ., thermal storage, cond.	7 Willans, 1 Parsons turbine	7 Oerlikon, 1 Parsons	4,400
365 LAMBETH	South London Electric Supply Co.	1899	H. W. Sprunt	200	50–, 1-ph.	11 B. & W., 2 Stirling, suphtrs., clg. tr., cond., econ.	4 Ferranti, 1 Yates & Thom	4 Ferranti, 1 B.T.H.	3,000
366 LONDON AND WESTMINSTER	London Electric Supply Corporation	1885	G. W. Partridge	100 & 200	83–, 1-ph.	12 Paxman, 17 B. & W	2 Hick-Hargreaves, 3 Plenty, 2 Allen, 1 Willans 1,000 KW., 2 Ferranti	8 Ferranti, 2 Dick Kerr	9,750
367 MARYLEBONE	Corporation	1887	F. A. Wilkinson	..	..	Undertaking purchased from Metropolitan Electric Supply Co. on 5th July, 1904; Company continues to supply under agreement, pending			
368 NOTTING HILL	Notting Hill Electric Lighting Co.	1891	G. Schultz	200	Direct	4 B. & W.	4 Willans	1 Siemens, 5 Crompton	600*
369 PADDINGTON, MARYLEBONE, HOLBORN, & WESTMINSTER	Metropolitan Electric Supply Co.	1887	J. S. Highfield	100 & 200 A.C., 200 D.C.	60–, 1-ph., & direct	69 B. & W., 4 Davey Paxman, 12 Fraser, stokers, cond., 4 clg. trs.	16 Willans, 5 Westinghouse, 10 Parsons turbines, 2 Sulzer	7 Elwell-Parker, 2 Latimer-Clarke, Siemens, 6 Johnson & Phillips, 10 Parsons, 5 Westinghouse, 2 Kolben	19,000
370 POPLAR	Corporation	1900	..	230 & 460	Direct	6 B. & W., suphtrs., stokers, cond.	2 Belliss, 2 Willans, 2 Parsons turbines	4 Mather & Platt D.C., 2 Peebles A.C.	3,400
371 ST. JAMES & PALL MALL	St. James & Pall Mall E. L. Co.	1889	S. T. Dobson	107 & 214	Direct	20 Economic, 8 loco., 2 B. & W.	17 Willans	17 Siemens	8,240*
372 ST. PANCRAS	Corporation	1891	S. W. Baynes	110 230 & 440	Direct*	10 B. & W., 5 Lanc., 5 dryback marine	18 Willans, 3 Belliss, 1 Peache, 3 Browett-Lindley	10 Kapp, 2 Latimer Clarke, 4 Siemens, 10 Crompton 1 A. E. G., D.C.; 2 A. E. G., A.C.	6,390
373 SHOREDITCH	Corporation	1897	C. N. Russell	150	Direct	8 B. & W., 5 dryback marine, destructor	6 Willans, 2 Belliss	9 E. C. C.	1,455
374 SMITHFIELD	Smithfield Markets Elec. Supply Co.	1897	E. Ridley	100 & 200	Direct	5 Paxman Economic	3 Paxman, 2 Belliss	4 E. C. C., 1 Parker	965
375 SOUTHWARK	Corporation	1899	D. M. Kinghorn	220 & 440	Direct	8 B. & W., stokers, econ.	5 Willans	4 Johnson & Phillips, 1 Siemens	1,212
376 STEPNEY	Corporation	1899	W. C. P. Tapper	240 & 480	Direct	6 B. & W., and 2 do. marine; also 6 B. & W. with Manlove Alliott 12-cell dest.	6 Willans, 1 Parsons Turbine	5 Mather & Platt, 1 Dick Kerr, 2 Parsons	2,720
377 SYDENHAM	South Metropolitan E. L. & P. Co.	1901	J. F. Jones	100	Direct	3 Hornsby water-tube, 1 B. & W.	1 Willans, 2 Hornsby, 3 Belliss	E.C.C.	855
378 WANDSWORTH	County of London Elec. Supply Co.	1897	C. P. Sparks	205	50–, 2-ph.	20 B. & W., ch. grate stokers, suphtrs., econ., cond.	11 Brush Universal, 2 Yates & Thom, 2 B. T.-H.	11 Mordey	4,900
379 WESTMINSTER	Westminster Elec. Supply Corp.	1891	A. B. W. Kennedy	200 & 400	Direct	36 Marine dryback, 17 B. & W.	43 Willans	43, various makers*	12,484*
380 WESTMINSTER & ST. JAMES	Central Electric Supply Co.	1902	A. B.W. Kennedy, S. T. Dobson*	6000	46–, 3-ph.	10 Morrin Climax w. t. (vertical)	9 Willans and 1 Belliss	6 Oerlikon and 1 A. E. G.	9,600
381 WOOLWICH, PLUMSTEAD & ELTHAM	Woolwich Corporation	1893	J. B. Mitchell	210 & 420*	Direct*	4 Paxman Economic, 4 loco., cond. (Woolwich) 4 B. & W., 12-cell Meldrum dest. (Plumstead)	4 Parsons turbines, 1 Allen, 1 Bumsted-Chandler (Woolwich) 5 Willans (Plumstead)	4 Parsons, 1 Allen, 1 Easton Anderson & Goolden (Woolwich) 6 Brit. Westinghouse (Plumstead)	1,798
382 WESTMINSTER (PART) & HOLBORN (PART)	Charing Cross, West End & City Elec. Supply Co.	1891	W. H. Patchell	100 & 200	Direct	2 Marine, 14 Hornsby water tube, suphtrs., econ., ind. draught, part cond.	14 Belliss	14 Siemens	4,400

~ = cycles per second.

2,884	1,694	15 kw. Sub-stn. Tudor, 575 kw. E. P. S., max. dis. 320 kw.	Bare copper and B.I. & H.	£236,761*	102,000	15 arc, 2 Nernst	280=1,104 h.p.	...	134,7-9	...	Lg. 4½, pb. lg. 1, pr. 2 to 1	Flat rate & scale	2,097,302	3.46
8,728	5,092	E. P. S., max. dis. 100 kw.	Callender, v. bit. armd. and solid	£417,375	254,784	100 arc.	374=2,014 h.p.	...	227,491 ex. tr.	...	Lg. 5 & 1½, pb. lg. 5 & 1½ pr. 1½, tr. 1½	Max. demand & flat rate	8,469,921	2.07
375	280	Hart, max. dis. 42 kw.	Triple conc., ppr.; fdrs. in ducts; dist. armd. direct; Johnson & Phillips, Callender and St. Helens	£23,000	19,881	20 arc, 115 Nernst	23=111 kw.	...	16,048	...	Lg. 6 & 5, or 5, pr. 3 & 1½, or 2½	Max. demand flat rate & scale	196,028	4.37*
150	100	... ...	Bare copper overhead, and conc. fdrs. armd. direct, B.I. & H.	£8,678	3,109	200 inc. ...	... ...	...	3,500	4	Lg. 4, 4½ & 6, pb. lg. contract	Sliding scale & contract	...	...
5,292	1,743	... ...	Bare cpr. in culvert, paper bit. and v.r. in pipes, solid, B.I. & H.	£216,682	...	... ...	... ...	...	54,154	...	Lg. 4 & 1½ pr. 2 to 1½, tr. 1½, pb. lg. 2½	Max. demand flat a scale	2,869,312	2.13
268	180	E. P. S., max. dis. 7 kw.	Callender, bit. lead covd.	£10,578	5,200	...	3=12 h.p. ...	...	...	6	Lg 7 & 3, pr. 3*	Max. demand & flat rate	96,892	6.2
34	17	Chloride, max. dis. 14 kw.	Bare copper	£2,000	1,014	23 inc. ...	1=5 h.p. ...	...	1,182	18.3	Lg. 6½, pb. lg. 4, pr. 3 ...	Flat rate with rebate	12,230	5.9
1,200	1,047	E. P. S., max. dis. 200 kw.	Silvertown h.p. fdrs., v.r. and diatrine, Callender l.p. dist. armd.	£145,401	60,934	32 arc, 48 inc.	42=180 h.p.	...	65,276	17	Lg. 6, pr. 3½, pb. lg. 2.3	Flat rate with discount	847,186	5.16
1,200 (lg.) 1,800 (sr.)	727 (lg.) 550 (tr.)	... ...	Callender, v. bit. conc. fdrs., conc. armd. dist.	£149,000	49,950	91 arc* ...	18=222 h.p.	100=2,500 h.p.	56,166	8.5	Lg. 4, pr. 2½, pb. lg. £25, tr. 2 to 1½	Flat rate & scale	1,757,800	3.81
1,050	660	Tudor, max. dis. 150 kw. ...	Fdrs. in ducts, dist. solid; all triple conc. lead covd. B.I. & H.	£78,155	34,437	238 arc, 69 Nernst	109=879 h.p.	...	64,709	63.2	Lg. 3½, pr. 1, pb. lg. .9d.	Flat rate ...	1,320,348	1.72
1,000	190	Tudor, max. dis. 75 kw. ...	B.I. & H. conc. and single lead covd. ppr. in C.I. pipes, and solid.	£30,000	2,050	13 arc, 300 inc.	6=20 h.p. ...	...	9,500	50	Lg., priv. & pb., 3, pr. 1½d.	Flat rate and contract	193,087	1.75
300	119	Chloride, 400 kw. hrs. ...	Callender, triple conc. solid in wood	£30,500	8,193	24 arc, 101 inc.	1=3 h.p. ...	...	9,108	24	Lg. 4½, pr. 3, pb. lg. contract	Flat rate and contract	180,309	3.76
100	46	Hart, 210 amp.-hrs.	Ppr. lead covd., fdrs. triple conc., dist. 3-core, solid in wood	...	2,391	6 arc ...	... ...	...	2,489	...	Lg. 7 & 3	Max. demand	...	...
1,175	420	E. P. S., 600 amp.-hrs. ...	Callender, triple conc. fdrs., v. bit. dist. solid, armd. for pipes, lead covd. for inc. ltg.	...	23,651	70 arc, 59 inc.	140 h.p. ...	40=1,400 h.p.	29,076 ex. tr.	...	Lg. 4, pb. lg. 1½, pr. 2 ...	Flat rate ...	...	...
840	402	2 Pritchetts & Gold, max. dia. lg. 7½ kw.; tr., 72 kw.	Callender, single, v. bit., fdrs. solid in wood troughs, dist. in Callender-Webber casing	£48,918	14,839	72 arc, 6 Nernst	23=54 h.p.	28=560 h.p.	31,568	...	Lg. 4½ & 4, pr. 1½, pb. lg. £12, tr. 2½ to 1½	Flat rate and scale	445,738	3.02
2,300	897	Tudor, 237 kw. for 5 hrs. ...	Ppr. lead covd. conc., B.I. & H. and Callender	£126,000	30,600	73 arc ...	...	78=1,700 h.p.	74,200	...	Lg. 4½, pr. 3, tr. 2.5 ...	Flat rate ...	1,279,743	3.38
169	116	Tudor, max. dis. 25 kw. ...	Callender, bare copper, and armd.	£11,412	6,612	6 arc, 1 Nernst	7=11 h.p. ...	...	7,015	10	Lg. 6, pb. lg. 4*, pr. 3 ...	Flat rate ...	76,823	5.71
600	... ...	... ...	Henley, paper, laid solid	£55,000	...	40 arc ...	10 h.p. ...	24=888 h.p.	...	...	Lg. & pr. 6 & 1½, pb. lg. & tr. 1½	2-rate meter	...	...
3,336	2,343	Tudor, max. dis. 100 kw. ...	Rubber, ppr., and diatrine	...	149,340	264 arc, 146 inc.	152=341 h.p.	...	163,980	...	Lg. 4½ pr. 1½, pb. lg. £18 & £3 3s.	Flat rate ...	2,717,210	...
1,460	1,300	... ...	B.I. & H., conc. armd. solid	£62,676	10,500	23 arc, 277 inc.	21=161 h.p.	8=200 h.p.	87,594	13	Lg. 4, pb. lg. 2, pr. 1, tr. 1 to ½	Flat rate ...	2,939,590	1.25
1,970	...	Tudor, 600 amp.-hrs. ...	Bare cpr. and ppr.; A.C. mains conc.	£192,750	58,779	43 arc ...	... ...	...	50,410	...	Lg. 4 & 2, pr. 1½	Max. demand & sl. scale	...	...
100	52	Tudor, 280 amp.-hrs. ...	V. bit. single solid	£22,000	2,465	15	... ...	... ...	...	...	Lg. 8 & 3	Max. demand	...	...
240	...	British Accumulator Co., max. dis. 88 kw.	Callender, ppr. lead covd., lg. fdrs. (3 cors) and tr. fdrs. in ducts, 3-core dist. laid solid in Howard troughing	...	3,000	...	3=3 h.p. ...	...	...	...	Lg. 5, pr. 2, tr. 1½ ...	Sliding scale	...	...
250	...	D.P.	Henley, ppr. lead covd., fdrs. triple conc. laid solid, dist. 3-core, solid and armd. direct	...	...	... ...	... ...	... ...	...	...	Lg. 7 & 3, pr 2	Max. demand & flat rate	...	...
750	306	Tudor, max. dis. 108 kw. ...	B.I. & H. paper lead covd., triple conc.	£88,712	22,094	109 arc, 418 inc.	3=9 h.p. ...	...	22,319	8.4	Lg. 4½, pr. 2 & 1½, pb. lg. £18 & £3½	Flat rate ...	547,780	Priv. 4.43 Pub. 2.62
2,675	1,235	Tudor, max. dis. 160 kw. ...	Conc. and single lead covd. and armd., also Simplified Underground Conductor system	£131,257	60,000	...	209=1,005 h.p.	...	90,000 approx.	23	Lg. 6 to 3, pr. 3 to 1½ ...	Sliding scale	1,018,000	3.78
435	184.	... ...	Henley & Glover paper, conc., lead covd., armd. ...	£21,584	8,773	311 inc.	25=165 h.p.	...	15,844	...	Lg. 5½ & 5, pr. 1½ & 1, pb. lg. £3	Flat rate or 2-rate meter	255,717	2.64
230	127	... ...	Callender bit., conc. lead covd	£30,000	12,300	4 inc. (7 amp.)	3=14 h.p. ...	...	12,000	...	Lg. 7 & 4, pr. 3	Max. demand and flat rate	...	...
495	...	Hart, 490 amp.-hrs.	Triple conc. fdrs. and dist., solid	£22,898	2,100	58 arc ...	3	...	3 045	...	Lg. 6 & 3, or 4½	Max. demand and flat rate	...	...
1,150	480	Tudor, 1,200 amp.-hrs.: max. dis. 700 amps for ½ hour	Bare cpr. strip, armd. rubber laid direct by Glover, Henley, and Silvertown, and Callender solid system	£83,080	42,023 inc. hg.	...	21=141 h.p.	...	43,906	20	Lg. 6, pr. 2½	Flat rate ...	473,771	...
1,976	391.5 lg. 517 tr.	Pritchetts & Gold, 600 amp.-hrs.	Glover diatrine and B.I. & H., ppr., lead covd., fdrs. s and 3-core in pipes and ducts, dist. armd. direct	£63,414	20,710	...	Appx. 50=376 h.p.	102=3,502 h.p.	38,852 exc. tr.	8.40	Lg. 6 & 2, or 4½, pr. 2 to 1, tr. 1½ to 1	Max. demand flat rate & sc.	1,160,593	1.98
80	43.3.	Hart, max. dis. 37 kw.	Silvertown vulc. rubber, laid solid	£5,255	1,500	36 Nernst ...	3=7 h.p. ...	...	2,622	25	Lg. 7, pb. lg. 2½, pr. 3 ...	Flat rate ...	26,308	6.11
1,208	751	E.P.S., 57 kw. for 5 hours. ...	Callender, conc., v. bit, and Glover diatrine	£47,905	17,990	...	29=80 h.p.	60=1,500 h.p.	54,111	5.2	Lg. 4½ to 4, pr. 1½ to 1, tr. 1½	Flat rate ...	1,227,007	2.02
34	24	... ...	B.I. & H. lead covd. armd. direct, lead covd. in pipes on pier	£3,000	56	35 arc, 22 inc.	... ...	... ...	...	...	... ...	... ...	... ...	... ...
43	...	... ...	B.I. & H. ppr., lead covd. in pipes	...	1,000	14 inc. ...	1 h.p. ...	...	1,050	...	Lg. 6	Flat rate ...	...	
190	100	E.P.S., 700 amp.-hours ...	B.I. & H., 3-core laid solid	£13,000	4,960	72 Nernst ...	... ...	... ...	5,300	41	Lg. 6, pb. lg. 4, pr. 3 ...	Flat rate and sliding scale	29,920	...
210	125.	... ...	Henley, paper lead covd., laid solid	£12,000	8,052	...	11=13½ h.p.	...	8,394	50	Lg. 5½, pr. 2½ & 3 ...	Flat rate ...	88,497	5
85	62.	... ...	Glover ppr., lead covd., armd., laid direct	£4,500	5,000	...	... ...	... ...	5,000	...	Lg. 4 & fixed charge, small houses 5	Hopkinson	42,600	...
192	85	D.P., max. dis., 144 kw. ...	Callender; fdrs. triple conc.; h.p. fdrs. conc.; dist. 3-core; lead covd. and armd., direct	£54,530	8,905	50 inc. ...	22 h.p. ...	...	9,945	87	Lg. 7 & 4, or 6, pr. 4 & 1½, or 2½	Max. demand & flat rate	78,505	4.95
750	179 lg., 400 tr.	Tudor, 30 kw.	B.I. & H. and Callender, conc. fdrs., single dist., solid in wood; paper ins., lead or v. bit. covd.	£39,005	15,065	34 arc, 58 inc., 109 Nernst	12=30 h.p.	*	22,694	...	Lg. 7 & 2, or 5½, pb. lg. & pr. 2½, tr. 2 to 1½	Max. demand & flat rate	589,500	3.6
80	...	Hart, max. dis. 30 kw. ...	Callender, 3-core, lead covd.	£6,000	2,000	...	14 h.p. ...	...	2,350	...	Lg. 5, pr. 2	Flat	...	...
1,340	1,007	Chloride, max. dis. 510 kw. ...	B.I. & H., and St. Helens, ppr., ld. covd. fdrs. single & tri. conc. solid, dist. single, solid conc. & single armd. direct	£127,956	24,496	35 arc, 70 inc.	160=854 h.p.	...	54,048	20.8	Lg. 4½, pr. 2 & 1, pb. lg. £15, tr. 1.11 & .37	Lg. flat, pr. m.d., tr. scale	2,089,744	1.85
160	48	Tudor, max. dis. 100 kw. ...	Paper, lead covd., laid solid in wood; B.I. & H. Helsby and Glover	£9,000	5,388	2 arc, 9 inc., 6 Nernst	1=2 h.p. ...	...	5,507	21	Lg. 6 & 3, pr. 3 & 1½, pb. lg. 2½	Max. demand & flat rate	41,380	4.66
6,520	3,600	Tudor, max. dis. 270 kw. ...	Glover, D.C., lead covd. ppr. single, fdrs. in ducts, dist. solid, A.C., lead covd. ppr. conc. in e.-ware pipes	£545,887	125,094	116 arc ...	370=2,960 h.p.	402=11,080 h.p.	444,342	23.4	Lg. 3½*, pb. lg. 1.22, pr. 2 to 1, tr. 1.5	Flat rate & sliding scale	9,002,319	1.732
600	249	D.P., 315 kw. hrs.	Callender, 3-core and triple conc. armd. direct	£61,795	20,468	35 inc. ...	36=132 h.p.	...	23,883	35	Lg. 7, 4 & 2, pr. 4 & 1½ ...	Max. demand	397,611	3.63
170	48.8	A.B.P. Co., max. dis. 77 kw.	B.I. & H., Callender & St. Helens; fdrs., l.c. & armd. direct and dialite solid; dist., dialite armd. direct	£14,000	7,200	...	10=20 h.p.	...	7,678	...	Lg. 6 & 6½, pr. 4	Flat rate ...	60,704	5.47
1,945	774	Tudor, 175 kw.	Siemens, B.I. & H. & Glover, v. r., tri. conc., ppr. fdrs. in c. i. pipes, dist. v. r. and triple conc. ppr.	£98,886	53,558	...	80=120 h.p.	36=1,120 h.p.	82,568	...	Lg. 7 & 3, or 6, pr. 2, tr. 1.3	Max. d. & flat rate with dis.	790,064	3.93
425	163	Tudor, max. dis. 40 kw. ...	Callender conc. and armd. fdrs., 3 core dist.	£52,387	10,019	15 arc, 341 inc., 16 Nernst	18=17½ h.p.	...	12,229	21	Ltg. 7 & 4, or 6, pr. 4 & 1½, or 2½	Max. demand and flat rate	179,328	3.6
330	169	Acc. Fabrik, max. dis. 80 kw	Callender, triple conc.	...	2,698	...	... ...	...	11,243	...	Lg. 7 & 2½, pr. 4 & 1½, tr. 2	Max. demand	157,889*	...
7,500	4,200	... ...	Glover, B.I. & H., etc., h. p. lead covd. diatrine conc., l.p. 3 & 4 core, lead covd.	£804,527 (inc. pur. fm. co.)	263,285	...	541=3,617 h.p.	...	339,710	28.1	Lg. 4, pr. 2 to 1 (w. dis. to .6)	Flat rate with discount	4,546,141	2.97
1,170	622	Tudor, max. dis. 150 kw. ...	Triple conc. ppr., lead covd., Western Electric, Anchor Cable Co., & Glover	£56,220	9,159	40 arc ...	71=596 h.p.	540 kw.*	...	...	Lg. 4½ & 2, pr. 2 & 1, or 1½, tr. 1½, pb. lg. 1½	Max. demand & flat rate	997,100	1.64
540	270	D. P.	Callender, dist. 3-core cable, fdrs. triple conc.	£45,320	17,944	44 arc, 136 inc.	23=70 h.p.	...	18,854	...	Lg. 6, 4 & 2, pr. 4 & 2, pb. lg. 3½ & 3	Max. demand	365,027	...
180	63	E. P. S., max. dis. 23 kw. ...	Callender lead covd. and armd.	£7,000	1,052	16 arc, 105 inc.	1=6 h.p. ...	...	1,650	...	Lg. 6 & 2, or 6, pr. 3 ...	Max. demand and flat rate	...	...
583	156	E. P. S., 87 kw. for 5 hours	Callender, v. bit. 3 single laid solid in C.I. troughing, 3-core lead covd. and armd., laid direct	£38,982	5,279	97 inc. ...	5=10½ h.p.	...	5,637	40	Lg 6, pb. lg. 3, pr. 3 & 2½	Flat rate with dis.	148,158*	4.50
2,400	1,065	... ...	Callender, l.p. laid solid; h.p. 3-core paper, ld. c., dra n into conduits; B.I. & H. 3-core solid in Doulto troughs	...	...	... ...	... ...	... ...	...	...	Lg. 7 & 2½, pr. 1½ ...	Max. demand & flat rate	...	...
2,200	1,407	Tudor, max. dis. 1,500 kw. ...	St. Helens, Callender, and Glover, bitumen and ppr. lead covd. cables	£179,351	54,969	92 arc, 66 inc., 6 Nernst	40=200 h.p.	50=1,250 h.p.	88,950	...	Lg. 4½, pb. lg. 2½, pr. 3 & 2, tr. 2½	Flat rate ...	2,174,922	2.86
1,475	910	Hart	Callender, triple conc., laid solid	...	...	44 arc. ...	... ...	... ...	...	...	Lg. 6 & 3, pr. 2, tr. 1½ ...	Max. demand & flat rate	...	...
2,350	1,435	... ...	B.I. & H., Siemens and Anchor, conc., lead covd. and armd.	£183,866	37,875	184 arc, 2 inc., 6 Nernst	29=288 h.p.	46=1,620 h.p.	139,714	34.7	Lg. 6, 4, & 2, pr. 2 & 1½, tr. 1½ to 1½, arc £20*	Max. demand	1,783,107	3.04
1,600	958	... ...	B.I. & H., ppr. and v. r., in pipes and ducts	£151,888	54,909	91 arc, 462 inc.	30 h.p. ...	...	59,209	10	Ltg. 7 & 2, or 5, pr. 2, arc £22½, inc. £2.6 (2×16)	Max. demand & flat rate	1,385,393	3
500	204	E.P.S., max dis. 92 kw. ...	B.I & H. and Glover, 3-core, lead. covd. and armd. ...	£23,698	8,619	1 Nernst 35 arc, 100 inc.	22=81½ h.p	...	12,051	17	to 1½ Lg. 4, pr. 1½, pb. lg. arc £15, inc. £3	& scale Flat rate w. dis. & contract	223,212	3.08
538	279	Hart, max. dis. 275 kw.-hrs.	Callender, v. bit., fdrs. conc.; dist., 3-core, drawn into stoneware ducts	£50,000	16,780	2,000 arc, 200 inc., 130 Nernst	22=80 h.p.	... ...	21,100	23.5	Lg. 6, pb. lg. 4.25 & 3.1. pr. 3 w. dis.	Flat rate with discount	340,054	...
675	385	Hart, max. dis. 100 kw. ...	Fdrs. triple conc., dist. 3 single, Dialite	£30,273	11,231	34 arc, 7 inc. 5 Nernst	11=30 h.p.	20=500 h.p.	26,864	...	Lg. 6 to 4½, tr. 2 & 1.3, pr. 2½*	Max. demand, scale & flat	303,268	3.12
735	382	... ...	B.I. & H. conc. armd.	£44,412	27,052	75 arc ...	15=37 h.p. ...	...	29,107	...	Lg. 6 & 4, pr. 3½	Max. demand & flat rate	...	...
1,860	810	Tudor, 1,000 amp.hrs. ...	Callender & Glover, conc. & triple conc. armd. direct, and v. bit. single	£110,964	46,823	67 arc, 3 inc 11 Nernst	146=658 h.p.	...	63,273	19	Lg. 7 & 1½, or 4½ to 3½, arc £17, pr. 1½ to 1	Max. demand & scale	904,000	2.84
2,000	1,370	Hart, max. dis. 500 kw. ...	Callender, conc., armd. and solid	£220,000	50,418	381 arc, 205 Nerns	620 h.p. ...	...	73,030	31	Lg. 4, pr. 1½, arc £18 ...	Flat rate with discounts	1,854,920	1.89
375	...	Tudor, 42 kw. for 6 hrs. ...	Glover, triple conc. diatrine lead covd., fdrs. in ducts, dist. solid.	£48,000	6,000	71 arc ...	... ...	... ...	...	...	Lg. 6 & 3, pr. 2½	Max. demand	...	...
3,500	2,408	E.P.S.	Various makers, in e.-ware ducts	£454,854	...	...	...	...	210,657	...	Lg. 6 & 3, pr. 3 & 2 ...	Max. demand	3,212,412	4.23
22,000	15,000	... ...	B.I. & H., conc., lead covd. ppr. in iron pipes	£2,098,035	538,189	505 arc ...	1,995=214,200 8 c.p.	...	752,389	17.4	Lg. 3.55, pb. lg. 2.47, pr. 1.99	Flat rate, sl. scale, etc.	17,634,110	3.29
12,000	7,240	Tudor, max. dis. 1,600 kw. ...	Siemens, B.I. & H., Felten & G., paper insd. laid solid	£1,186,631	245,756	...	2,213 h.p. ...	...	301,081 + bulk supply	24.3 + bulk inc.	Lg. 5 to 2, pr. 2½ to 1 ...	Flat rate, sl. scale & cont.	7,351,737	2.56
4,350	2,824	Tudor, 595 kw. hrs.	H.p. conc. ppr., l.p. bit. fibre & ppr. conc., lead covd. and armd., power v.r. & ppr. conc.	£1,388,593	375,969	...	6,054 h.p. ...	...	567,589	...	Lg. 7 & 3, or 6, pr. 2½ w. disc. to 30%	Mx. dem., flat rate & scale	7,181,309	4.12
2,250	1,008	... ...	B.I. & H., ppr., conc. lead covd.	£220,000	51,403	274 arc, 40 inc., 8 Nernst	54=640 h.p.	...	71,645	...	Lg. 3½, pb. lg.* arc £25, pr. 1	Sliding scale & flat rate	1,835,052	2.45
3,100 (about)	...	... ...	B.I. & H. conc.	£328 264	108,891	...	About 600 kw.	...	121,533	...	Lg. 6, pr. 2	Flat & two rate meter	...	4.24
3,372	1,479	Tudor, 300 kw. for 4 hrs. ...	B.I. & H. and Western Electric, triple conc. lead covd. solid in iron and e.-ware.	£285,000	20,000	293 arc ...	... ...	... ...	...	...	Lg. 4, pr. 2	Flat rate ...	...	...
2,500	2,426	... ...	Callender conc., in pipes and armd. direct; Western Electric conc. in earthenware ducts	£210,994	68,069	223 arc, 63 inc.	180=1,208 h.p.	...	98,869	9	Lg. 6 & 3*, pr. 1½; arc £30 p.a.	Max. demand*	2,948,633	2.9
4,345	2,685	... ...	H. p. conc., l.p. triple conc. and 3-core, various makers	...	212,306	122 arc, 41 Nernst	84=401 h.p.	...	224,400	...	Lg. 6 & 2½, pr. 2; arc £28 p.a.	Max. demand and flat rate	...	...
3,600	2,342	Tudor, 30 kw. for 3 hrs. (exciting)	V. r. conc., h. p. in c. i. pipes, l. p. in e.w. pipes and paper, laid solid	£410,000	98,092	490 arc ...	144=682 h.p.	...	121,988	39.87	Lg. 7 & 4, or 5, pb. lg. 3½, pr. 2 to 1½	Max. demand & flat rate	3,097,064	3.95
2,830	1,851	... ...	B.I. & H., h.p. twin, l.p. conc.	£253,987	169,869	...	9=238 h.p.	...	176,540	...	Lg. 5½ to 4, pb. lg. 2½, pr. 2, tr. 2	Flat rate with discounts	3,544,758	4.50
5,800*	3,467	Tudor and Accumulator Industries, max. dis. 800 kw.	Henley, Callender, B.I. & H. & bare copper; 3-ph. 5,000 v. mains from Wood Lane, B.I. & H. ppr., lead covd.	£355,144	302,315	44 arc ...	200 h.p. ... (about)	...	303,048	8	Lg. 5 to 3, pb. lg. 2½, pr. 3 to 2	Flat rate with discounts	4,558,176	3.95
4,400	2,803.6	Hart, 15 kw. for 3 hrs. (exc.)	B.I. & H. 3 core, ppr., lead. covd. in ducts	£149,519	...	...	4,090 kw. (motor-gen.)	...	...	...	... ...	... ...	...	...
3,000	3,634*	... ...	B.I. & H. conc., ppr., lead covd.	£341,258	94,253	30 arc ...	151=606 h.p.	*	108,085	17.6	Lg. 7 & 2, or 4½, pr. 2, tr. 1.4	Max. demand & flat rate	9,205,342	1.85
9,750	5,020	... ...	B.I. & H., Siemens, Fowler	£1,022,770	183,000	...	... ...	...	238,542	8.75	Lg. 6 to 3½, or 6 & 3, pr. 3 to 1½	Sldg. scale & max. demand	10,531,785	2.6
ement, pending completion of Corporation Generating Station.														
600*	1,400	Tudor, 3,000 amp.	Bare copper, & B.I. & H. paper, lead covd., and St. Helens diatrine	£224,267	123,532	45 arc ...	60=120 h.p.	...	132,132	12	Lg. 5, pb. lg. 2½ to 2, pr 3, 2 & 1½	Flat rate with discounts	1,645,492	4.7
19,030	14,596	Acc. Industries, 960 kw.; E.P.S., 2,520 kw.; Chloride, 900 kw.	B.I. & H. fdrs., conc. & triple conc. ppr.; Silvertown, Henley, B.I. & H. dist. v.r. and ppr.	£1,539,582 (Dec., 1904)	881,500	6 arc ...	2,450 h.p. ...	...	946,700 (Mar., 1905)	12	Lg. 6 to 5, pr. 3 & 1½; pb. lg. £30 p.a.	Flat rate, ta ax. dem. & and sl. scale	15,232,889 (Dec., 1904)	4.65
3,400	1,224	Hart, max. dis. 180 kw. ...	B.I. & H. 6-core fdrs., 5-core dist., solid in troughs ...	£187,000	31,434	320 arc, 521 inc.	130=1,706 h.p.	...	79,455	45	Lg. 5 & 3, pb. lg. 1½ pr. 1½	Max. demand & flat rate	...	...
8,240*	4,988*	E. P. S., max. dis. 220 kw. ...	Bare cpr., insd. cables in ducts, and armd.	£438,323	277,719	71 arc ...	... ...	... ...	278,889	9½	Lg. 6 to 4, pr. 3 to 2, loss 8 %	Flat rate with discount	7,515,341	3.74
6,890	3,193	... ...	Fibre, lead covd., armd., v.r. arc cables, bare cpr., Callender and others	£460,868	...	461 arc ...	315 h.p. ...	... ...	244,438	...	Lg. 6 & 1½, or 4, pb lg. 3, pr. 1	Max. demand & flat rate	4,730,341	3.84
1,455	1,460	Pritchetts & Gold, 60 kw. for 6 hrs.	Glover, Henley, B.I. & H.	£196,912	...	260 arc ...	... ...	... ...	...	...	Lg. 5 & 2, or 4½, pr. 2 ...	Max. demand & flat rate	...	...
965	706	Chloride, max. dis. 157 kw. ...	Bare cpr. and Callender v. bitumen	£121,993	30,111	618 eq. 8 c.p.	258 h.p. ...	...	37,944	21.7	Lg. 6 to 3½, pr. 2½ to 1½ ...	Sliding scale	1,231,046	3.66
1,212	525	Pritchetts & Gold, 22 kw. for 6 hrs.	Lead covd. conc., B.I. & H.	£79,570	26,424	90 arc, 361 inc.	26=110 h.p.	...	...	...	Lg. 6, 4, & 2, pr. 2½ ...	Max. demand & flat rate	677,381	3.66
2,790	1,684	Tudor, max. dis. 160 kw. ...	B.I. & H., St. Helens and Henley, ppr. lead covd., fdrs. single, dist. single and triple conc.	£216,267	78,070	374 arc, 2 inc., 112 Nernst	236=1,240 h.p.	...	123,532	39	Lg. 8 & 1, pr. 1	Max. demand & flat rate	3,495,153	2.11
855	609	E.P.S., 125 kw. for 3½ hrs. ...	Conc. single lead covd. ppr., v. b.t. & v.r., direct, in pipes, & solid; B.I. & H., Callender, Henley	£116,090	27,045	...	16=46 h.p.	...	28,087	21	Lg. 6, pr. 3	Sliding scale	412,540	5.18
4,900	3,142	... ...	H. p. & e. h. p., v.r. armd., & ppr lead covd. & armd. l.p. bit. fibre & ppr. lead covd. armd. conc.	£1,388,593	375,969	...	... ...	...	567,580	...	Lg. 7 & 3, or 6, pr. 2½ with dis. to 30%	Max. demand, dat rate a scale	7,181,309	4.12
12,484*	8,125	... ...	Bare cpr. in ducts, and Callender, in Callender Webber casing and fibre pipes	£1,015,480	...	954 arc, also some inc. & N.	... ...	... ...	711,679	7.48	Lg. 5½ with rebates, pr. 2½ do.	Scale ...	14,518,764	4
9,800	4,973	... ...	Callender 3 core, ppr. lead covd. armd., laid solid in iron troughs	£446,770	...	...	6,800 kw. (motor-gen.)	...	...	...	Bulk, 1½	Flat rate ...	6,214,873	1.75
1,736	737	... ...	Callender, triple conc. fdrs. armd. direct, 3-core dist. armd. direct, & v. bit solid	£163 965	41,154	77 arc, 154 inc. 18 Nernst	220 h.p. ...	...	51,104	...	Lg. 7 & 2½, or 4, pr. 2 to 1½	Max demand, flat & scale	744,610	...
4,400	4,000	Tudor & Pflager, max. dis. 1,200 kw.	Siemens, B.I. & H., Callender, and Felten & G., jute armd. laid direct, ppr. and bit. laid solid	£981,088	309,993	175 arc ...	3,954 h.p. ...	...	409,603 + bulk supply	27.9 + bulk inc.	Lg. 5 to 4, pr. & hlg. 3 to 1½	Flat rate, sl. scale & cont.	8,604,109	3.4

	F. M. Long ..	220 & 440	Direct ..	7 B. & W., 4 dryback, econ.	6 Willans, 1 Parsons turbines ..	3 Laurence Scott, 3 Siemens ..	2,834	1,894	[illegible]	Base copper and B.I. & H. ..
	H. Talbot ..	200 & 400	Direct ..	16 Lanc., 14 dryback, econ., feed htr., 6 D. & W. with 12-cell Manlove dest.	32 Willans	32 Siemens	8,728	5,092	E. P. S., max. dis. 100 KW. ..	Callender, v. bit. armd. and solid .. ..
	S. C. Gibson ..	220 & 440	Direct ..	3 B. & W., economiser, cond.	2 Willans, 1 Paxman	1 Johnson & Phillips, 1 Siemens, 1 E.C.C.	975	220	Hart, max. dis. 42 KW. ..	Triple conc., ppr.; fdrs. in ducts; dist. a Johnson & Phillips, Callender and St. H
	T. Thomas ..	100 to 220	40~, 1-ph., & direct	2 B. & W.	1 Bobey, 2 Paxman	2 Parker, D.C.; 2 Siemens A.C. ..	150	100	.. ..	Bare copper overhead, and conc. fdrs. a B. I. & H.
	S. W. Newington	210 & 420	Direct ..	8 Lanc., 8 Marine, 3 Climax, cond., 8 destructor cells	16 Willans, 1 Parsons turbine ..	4 Hall, 12 Siemens, 1 Parsons ..	5,292	1,743	.. ..	Bare cpr. in culvert, paper bit. and v.r. in B.I. & H.
	E. B. Smith ..	220	Direct ..	2 loco., 2 B. & W., ch. gr. stoker	2 Marshall, 2 Bellis, 1 Scott & Mountain	2 Parker, 1 Siemens, 1 Scott & Mountain, 1 McClure	258	190	E. P. S., max. dis. 7 KW. ..	Callender, bit. lead covd. .. .. ..
	B. Barber ..	230	Direct ..	1 loco., 1 Cornish	1 Paxman, 1 Hornsby	1 Laurence Scott, 1 Harrison Engineering Co.	34	17	Chloride, max. dis. 14 KW. ..	Bare copper .. ..
	F. H. Francis ..	100	Direct ..	5 loco., 2 Economic; cond.	5 McLaren, 1 Willans, 1 Bellis ..	7 Electric Construction Co.	1,200	1,047	E. P. S., max. dis. 200 KW. ..	Silvertown h.p. fdrs., v.r. and diatrine, C dist. armd.
	C. F. Parkinson	200 A.C. 500 D.C. (tr.)	50~, 1-ph. & direct	8 B. & W., stokers	1 Adamson, 2 Ferranti, 2 Peache, 2 Davey Paxman	2 Ferranti, 2 Schuckert, A.C.; 1 Schuckert, 2 Bruce Peebles, D.C.	1,200 (lg.) 1,800 (tr.)	727 (lg.) 550 (tr.)	.. ..	Callender, v. bit. conc. fdrs., conc. armd. di
	H. B. Maxwell ..	240 & 480	Direct	4 B. & W., 1 Stirling, econ., Manlove Alliott 6-cell dest.	5 Bellis	4 Peebles, 2 Greenwood & Batley ..	1,050	660	Tudor, max. dis. 150 KW. ..	Fdrs. in ducts, dist. solid, all triple conc. B.I. & H.
	J. Slevin ..	230 & 460	Direct ..	3 Lanc., cond., clg. tr.	4 Bellis	2 Mather & Platt, 2 Dick Kerr ..	1,000	190	Tudor, max. dis. 75 KW. ..	B.I. & H., conc. and single lead covd. ppr. i and solid.
	S. L. R. Price ..	220 & 440	Direct ..	3 Lanc., 1 B. & W., stokers, econ., cond.	2 Easton	4 Easton	300	119	Chloride, 400 KW. hrs. ..	Callender, triple conc. solid in wood ..
	S. G. Loech ..	230 & 460	Direct ..	2 B. & W., feed htr.	2 Brush Universal	2 Brush	100	46	Hart, 210 amp.-hrs.	Ppr. lead covd., fdrs. triple conc., dist. 3-c wood
	J. Lambert ..	230 & 460	Direct ..	4 B. & W., cond., econ.	4 Willans, 1 Brush	3 Peebles, 2 Brit. Elec. Plant Co. ..	1,175	420	E. P. S., 600 amp.-hrs. ..	Callender, triple conc. fdrs., v. bit. dist. for conc., lead covd. for inc. ltg.
	J. C. Gill ..	200 & 400	Direct ..	4 Lanc., cond., econ.	5 Willans, 1 Bellis	2 G.E.Co., 1 Peebles, 3 Crompton ..	840	402	2 Pritchetts & Gold, max. dis. lg. 72 KW.; tr., 72 KW.	Callender, single, v. bit., fdrs. solid in wo dist. in Callender-Webber casing
	E. G. Okell ..	100 & 200	50~, 1-ph., D.C. for tr.	9 Lanc., stokers, econ., cond.	5 Bellis, 2 Ferranti	6 Ferranti, 3 Westinghouse	2,300	897	Tudor, 237 KW. for 5 hrs. ..	Ppr. lead covd. conc., B.I. & H. and Callend
	..	108	Direct ..	3 loco., feed htr.	4 Willans	3 Crompton, 1 Parker	169	116	Tudor, max. dis. 25 KW. ..	Callender, bare copper, and armd. .. ..
	J. E. Teasdel ..	220 & 440	Direct ..	3 B. & W., econ., Heenan 3-cell dest.	3 Combe-Barbour	3 Greenwood & Batley	600	..	.. ..	Henley, paper, laid solid .. .. ..
	W. S. Foale ..	100	50~, 1-ph.	18 Lanc., stokers, econ., cond.	5 Yates & Thom, 3 Parsons turbines	4 Ferranti, 1 Brown-Boveri, 3 Parsons	3,336	2,343	Tudor, max. dis. 100 KW. ..	Rubber, ppr., and diatrine .. .. ..
	R. P. Nash ..	100 A.C., 250 & 550 D.C.	100~, 1 ph. & direct	5 Lanc., stokers, suphtrs., econ., cond., clg. tr. ..	3 Browett-Lindley, 1 Alley and MacLellan, 1 Ferranti, 1 Willans	1 Eng'lish Electric, 1 Peebles, 1 Silvertown, 3 Johnson & Phillips	1,460	1,300	.. ..	B.I. & H., conc. armd. solid .. ..
	J. H. Tonge ..	250	50~, 1-ph., & direct	6 Lane., 3 dryback	5 Bellis, 3 Willans	2 Clark-Muirhead, 2 Siemens, 2 E.C.C. direct, 2 E.C.C. altg.	1,970	..	Tudor, 600 amp.-hrs.	Bare cpr. and ppr.; A.C. mains conc. ..
	W. H. Joyce ..	230 & 460	Direct ..	2 B. & W.	2 Belliss	2 B.T.H.	100	52	Tudor, 280 amp.-hrs.	V. bit. single solid .. ..
	M. B. Henry ..	220	Direct ..	2 Lanc.	2 Browett-Lindley	2 Mather & Platt	240	..	British Accumulator Co., max. dis. 88 KW.	Callender, ppr. lead covd., lg. fdrs. (3 core) a in ducts, 3-core dist. laid solid in Howard
	M. Farrer ..	240 & 480	Direct ..	2 Hornsby	2 Belliss	2 Parker	250	..	D.P.	Henley, ppr. lead covd., fdrs. triple conc. dist. 3-core, solid and armd. direct
	G. F. Pilditch ..	230 & 440	Direct ..	3 Lanc., stokers, econ., Heenan & Froude 6-cell dest.	3 Willans	4 Mather & Platt, 2 Dick Kerr. ..	750	306	Tudor, max. dis. 108 KW. ..	B.I. & H. paper lead covd., triple conc. ..
	A. T. Cooper ..	200 A.C., 200 & 400 D.C.	67~, 1-ph. & direct	4 Lanc., 2 B. & W., econ., suphtrs.	3 Fowler, 5 Belliss, 2 Willans (gas)	3 Fowler, A.C., 8 E.C.C. and 5 Siemens D.C.	2,675	1,295	Tudor, max. dis. 160 KW. ..	Conc. and single lead covd. and armd., also Underground Conductor system
	W. J. Ferguson ..	200	66~, 1-ph.	Dowson gas plant	3 Premier, 1 Willans, gas engines	3 Johnson & Phillips, 1 E.C.C. ..	435	184.	.. ..	Henley & Glover paper, conc., lead covd., ar
	W. S. Ross ..	200	50~, 1-ph.	2 B. & W., suphtrs., econ., detartariser	3 Allen	3 E.C.C.	230	127	.. ..	Callender bit., conc. lead covd .. ..
	E. H. Wright ..	230	Direct ..	4 B. & W.	3 Alley and MacLellan	3 Lancashire D. & M. Co.	495	..	Hart, 490 amp.-hrs.	Triple conc. fdrs. and dist., solid .. ..
	L. P. Greig ..	110 & 220	Direct ..	3 Penman dryback, 3 Paxman Economic ..	2 Paul, 2 Brush, 3 Belliss	2 Clark-Muirhead, 2 Brush, 3 Westinghouse	1,150	480.	Tudor, 1,200 amp.-hrs.: max. dis. 700 amps for ½ hour	Bare cpr. strip, armd. rubber lead direct Henley, and Silvertown, and Callender oil
	C. C. Atchison ..	220 & 440 D.C. 3,000 A.C.	50~, 3-ph., & direct	5 Lanc., stokers, cond., econ.	5 Belliss, 2 Browett-Lindley ..	1 E.C.C., 2 Siemens, 2 Johnson-Lundell, D.C.; 2 B.T H., A.C.	1,976	891.5 lg. 517 tr.	Pritchetts & Gold, 600 amp.-hrs.	Glover diatrine and B.I. & H., ppr., lead s and 3-core in pipes and ducts, dist. armd
	A. P. Lumsden ..	230	Direct ..	2 Marshall loco-type	2 Tangye	2 Silvertown	80	43.3.	Hart, max. dis. 37 KW. ..	Silvertown vulc. rubber, laid solid. ..
	Edward Cross ..	230 & 440	Direct ..	7 Lancashire	8 Allen	7 Allen, 1 Siemens	1,208	751.	E.P.S., 57 KW. for 5 hours ..	Callender, conc., v. bit, and Glover diatrine
	E. B. Stiven ..	230 & 460	Direct ..	2 Lancashire	2 Alley & MacLellan	2 Parker	84	24	.. ..	B.I. & H. lead covd. armd. direct, lead co on pier
	A. Jupp	100	Direct ..	1 Paxman	1 Browett-Lindley, 1 Bellis ..	1 Flather, 1 Silvertown	43	..	.. ..	B.I. & H. ppr., lead covd. in pipes ..
	H. Love	230 & 460	Direct ..	Gas plant	2 Campbell gas engines	2 Greenwood & Batley	160	100	E.P.S., 700 amp.-hours ..	B.I. & H., 3-core laid solid .. .. ..
	T. S. Shenton ..	230	50~, 3-ph.	.. ..	2 Willans	2 B.T.H.	210	125.	.. ..	Henley, paper lead covd., laid solid ..
	A. E. Lee ..	100	100~, 1-ph.	Dowson gas plant, 1 vertical boiler	2 Crossley (gas)	2 Brush	85	62.	.. ..	Glover ppr., lead covd., armd., laid direct
	A. E. Mayes (Eng. & Man.)	240 & 480	Direct, & 50~, 1-ph.	2 Tangye gas producers, w. vert. boilers, clg. tr.	2 3-cyl. Tangye, vert. Reavell compr. for starting	2 Parker	192	85	D.P., max. dis., 144 KW. ..	Callender; fdrs. triple conc.; h.p. fdrs. 3-core; lead covd. and armd., direct
	J. H. Clothier ..	240	Direct ..	4 Dryback	5 Willans	2 Parker, 3 Dick Kerr	750	179 lg., 400 tr.	Tudor, 30 KW.	B.I. & H. and Callender, conc. fdrs., single in wood; paper ins., lead or v. bit. covd.
	A. B. Child ..	110 & 220	Direct ..	2 Dowson suction gas producers	2 Premier gas	4 Mackie	80	..	Hart, max. dis. 30 KW. ..	Callender, 3-core, lead covd. .. ..
	E. M. Hollingsworth	230	Direct ..	4 Lanc., 4 B. & W., cond., econ., Beaman & Deas 4-cell destructor	9 Willans	4 Mather & Platt, 2 Dick Kerr ..	1,340	1,007	Chloride, max. dis. 510 KW. ..	B.I. & H., and St. Helens, ppr., id. covd. fdrs. conc. solid, dist. single, solid conc. & single
	C. J. Wood ..	230 & 460	Direct ..	Energy supplied in bulk by Trafford at 3,000 v., 3-ph.	Power & Light Co., 30~.	4 British Schuckert Motor Generators	100	48	Tudor, max. dis. 100 KW. ..	Paper, lead covd., laid solid in wood; B.I. & Glover
	C. D. Taite ..	220, 440 D.C., 200 A.C.	75~, 1-ph., & direct	16 Lanc., stokers, cond., econ.	8 Browett-Lindley, 1 Mather & Platt	9 Mather & Platt	6,520	3,600	Tudor, max. dis. 270 KW. ..	Glover, D.C., lead covd. ppr. single, fdrs. in solid, A.C., lead covd. ppr. conc. in e.-ware
	A. B. Randall ..	210	Direct ..	4 B. & W., suphtrs., ch. gr. stokers, cond. ..	4 Belliss, 1 Gilkes turbine (water) ..	4 Parker, 1 Parker generator-balancer and boosters=4 machines	600	249	D.P., 315 KW. hrs.	Callender, 3-core and triple conc. armd. dire
	P. E. A. Warren	220	Direct ..	1 Paxman loco.; 2 Dowson gas generators, with Cochran boiler	1 Belliss (steam), 1 National, 1 Crossley (gas)	1 International (dir. cpld.); 1 Bruce Peebles, 1 Newton Elec. Works belt driven)	170	48.8	A.B.P. Co., max. dis. 77 KW.	B.I. & H., Callender & St. Helens; fdrs., l direct and dialite solid; dist., dialite armd
	F. G. Holden ..	100 & 200 A.C., 500 D.C.	80~, 1-ph., & direct	5 Lanc. (4 Meldrum furnaces, 1 Crosskwaite), econ.	7 Parsons turbines	7 Parsons (5 A.C., 2 D.C.)	1,945	774	Tudor, 175 KW.	Siemens, B.I. & H. & Glover, v. r., tri. conc. in c. i. pipes, dist. v. r. and triple conc. p
	A. E. Mayes (Eng. & Man.) C. H. Finnis (Asst.)	240 & 480	Direct ..	3 B. & W.	3 Peache	3 Parker	425	163	Tudor, max. dis. 40 KW. ..	Callender conc. and armd. fdrs., 3 core dist.
	H. J. Nisbet ..	230 & 460	Direct ..	3 B. & W., suphtrs., cond., clg. trs.	3 Browett-Lindley	3 Brush	330	169	Acc. Fabrik, max. dis. 80 KW	Callender, triple conc. .. .. ..
	S. E. Fedden ..	200	50~, 2-ph.	(5 B. & W., 8 marine, stokers, econ. (Sheaf St.) .. (2 Stirling (Neepsend)	1 Ferranti, 4 McLaren, 2 Parsons, 1 Browett-Lindley 2 Parsons (Neepsend)	3 Ferranti, 2 Parsons, 2 E. C. C., 1 Brush 2 Parsons	7,500	4,200	.. ..	Glover, B.I. & H., etc., h. p. lead covd. dist l.p. 3 & 4 core, lead covd.
	S. D. Schofield	230, 460 & 500	Direct ..	4 Lanc., econ., suphtrs., Meldrum 4-cell dest. ..	4 Parsons turbines	4 Parsons	1,170	622	Tudor, max. dis. 150 KW. ..	Triple conc. ppr., lead covd., Western Electr Cable Co., & Glover
	C. M. Johnston	210 & 420	Direct ..	3 Lanc., 4 B. & W., econ.	6 Bellis	6 Parker	540	270	D. P.	Callender, dist. 3-core cable, fdrs. triple conc
	R. G. S. Yates ..	220	Direct ..	2 Robey loco., 1 B. & W.	2 Willans, 1 Bellis	2 Laurence Scott, 1 Parker	180	63	E. P. S., max. dis. 23 KW. ..	Callender lead covd. and armd. .. ..
	A. E. Farrow ..	220 & 440	Direct ..	2 Paxman econ., Paxman superheater	3 Davey Paxman	5 Siemens	580	156	E. P. S., 87 KW. for 5 hours	Callender, v. bit. 3 single laid solid in C.I. 3-core lead covd. and armd., laid direct
	S. A. Mahood ..	250 & 500 D.C. 5,500 A.C.	25~, 3-ph., & direct	5 B. & W., stokers, econ., purifier	6 Brush	3 B.T.H., A.C.; 3 Brush, D.C. ..	2,400	1,065	.. ..	Callender, l.p. laid solid; h.p. 3-core paper, l into conduits; B.I. & H. 3-core solid in Doult
	H. F. Street ..	200	Direct ..	3 Lanc., 8 B. & W.	5 Willans, 2 Ferranti, 1 Bellis, 2 Pollit & Wigzell (horizontal)	6 Crompton, 2 Schuckert, 2 Dick Kerr	2,900	1,407	Tudor, max. dis. 1,500 KW. ..	St. Helens, Callender, and Glover, bitumen lead covd. cables
	R. Birkett ..	230 & 460	Direct ..	3 Davey Paxman Economic, 2 B. & W., 2 Stirling, suphtrs., ch. grate stokers	3 Willans, 2 Bow Maclachlan, Howden	2 Crompton, 1 E. C. 1 Bruce Peebles, 2 Bow Maclachlan ..	1,475	910	Hart	Callender, triple conc., laid solid .. ..
	R. S. Downe ..	100 & 210 A.C., 500 D.C.	50~, 1-ph., & direct	9 Lanc., econ., suphtrs., cond.	4 Musgrave, 4 Bellis	5 Ferranti, 3 Bruce Peebles	2,350	1,435	.. ..	B.I. & H., Siemens and Anchor, conc., lead armd.
	J. H. Cawthra ..	110 & 220	50~, 1-ph.	5 Marine	6 McLaren	4 Ferranti, 1 Brown, 1 Siemens ..	1,600	953	.. ..	B.I. & H., ppr. and v. r., in pipes and ducts
	J. P. Crowther	230, 460 D.C. 220 & 440	& direct Direct ..	3 Lanc., cond., econ.	3 Scott & Mountain, 1 Belliss ..	Peebles, D.C. 3 Witting Bros., 1 Electrical Co. ..	500	204	E.P.S., max dis. 92 KW. ..	B.I & H. and Glover, 3-core, lead. covd. and
	G. Porter ..	230 & 440	Direct ..	3 dryback marine, econ., purifier, cond.	3 Scott & Mountain, 1 Allen ..	3 Scott & Mountain, 1 Mather & Platt	538	279	Hart, max. dis. 275 KW.-hrs.	Callender, v. bit., fdrs. conc.; dist., 3-core, stoneware ducts .. ..
	W. Sillery ..	230 & 460	Direct ..	1 Lanc., 3 B. & W., stokers, feed htr. and softener, cond.; Meldrum dest., 4 cells.	4 Willans	4 Lancashire D. & M. Co.	675	385	Hart, max. dis. 100 KW. ..	Fdrs. triple conc., dist. 3 single, Dialite ..
	G. Bryatt ..	100 & 200	88~, 1 ph.	6 B & W., cond., econ.	7 Willans, 1 Peache	6 Crompton A.C., 4 do. series arc ..	735	382	.. ..	B.I. & H. conc. armd. .. .. ..
	C. A. Midgley ..	230 & 460	Direct ..	5 B. & W., 2 Lanc., stokers, econ., Manlove-Alliott 4-cell dest.	8 Willans	6 Crompton, 2 Dick Kerr	1,860	810	Tudor, 1,000 amp.hrs. ..	Callender & Glover, conc. & triple conc. arm and v. bit. single
	W. Augustus Kenm	230 & 460	Direct ..	6 B. & W., stokers, cond.	5 Willans, 2 Parsons turbine ..	7 Mather & Platt, 2 Parsons ..	2,000	1,370	Hart, max. dis. 500 KW. ..	Callender, conc., armd. and solid .. ..
	W. E. J. Heenan	240	Direct ..	3 B. & W., econ., destructor	3 Willans	3 Thames Iron Works	375	..	Tudor, 42 KW. for 6 hrs. ..	Glover, triple conc. diatrine lead covd., ducts, dist. solid.
	Percy Still ..	230	Direct ..	21 B. & W.	21 Willans	21 E.C.C.	3,500	2,408	E.P.S.	Various makers, in e.-ware ducts .. ..
	F. Bailey ..	204 & 410 D.C. 204 A.C.	Direct, & 100~, 1-ph.	46 B. & W., 13 Economic, stokers, cond.	2 Ferranti, 8 Brush, 12 Willans, 3 Allis, 4 Musgrave	3 Ferranti, 8 Brush, 13 Thomson-Houston, 7 Westinghouse	22,000	15,000	.. ..	B.I. & H., conc., lead covd. ppr. in iron pipes
	W. H. Patchell ..	100, 200, & 400	Direct ..	14 Hornsby water tube	5 Sulzer, 2 Belliss	7 Lahmeyer	12,000	7,240	Tudor, max. dis. 1,600 KW. ..	Siemens, B.I. & H., Felten & G., paper insd.
	C. P. Sparks ..	104 A.C., 530 D.C.	50~, 2-ph. & direct	17 B. & W., ch. grate stokers, suphtrs., cond., econ.	9 Brush, 2 Allis, 2 Yates & Thom ..	3 Mordey, 6 E.C.C. A.C., 4 B.T.H. D.C.	4,350	2,824	Tudor, 595 KW. hrs.	H.p. conc. ppr., l.p. bit. fibre & ppr. conc., and armd., power v.r. & ppr. conc.
	Arthur J. Fuller	230	50~, 2-ph.	3 dryback, 6 B. & W., 2 Stirling, stokers, econ., cond.; Horsfall destructor, 12 cells	1 Bellias, 3 Musgrave	1 Dick Kerr, 3 G.E.Co., 1 Curtis turbine	2,250	1,008	.. ..	B.I. & H., ppr., conc. lead covd. .. ..
	I.A. Constable (Nn.) W. J. Albright (St.)	230	50~, 2-ph.	6 B. & W.	Bellias	E.C.C.	3,100 (about)	..	.. ..	B.I. & H. conc. .. ..
	L. L. Robinson	240 & 480	Direct ..	9 B. & W., econ., cond., clg. tr., Hughes & Stirling 12-cell dest. w. motor driven forced draught	3 Belliss, 2 Willans	8 Johnson-Lundell (Holmes), 1 Brit. Westinghouse	3,372	1,479	Tudor, 300 KW. for 4 hrs. ..	B.I. & H. and Western Electric, triple conc. solid in iron and e.-ware.
	G. G. Bell ..	110 & 220	50~, 1-ph.	6 Water-tube, 1 Lanc., cond.	3 McLaren, 1 Belliss, 3 Robey, 2 Musgrave	5 Ferranti, 2 E.C.C., 2 Siemens ..	2,500	2,426	.. ..	Callender conc., in pipes and armd. direct Electric conc. in earthenware ducts ..
	G. H. Cottam ..	105 & 210	90~, 1-ph.	4 Lanc., 4 Marine (ind. draught), 14 Economic, cond., econ.	9 Willans, 2 Ferranti, 4 Belliss ..	10 Siemens, 4 Ferranti, 1 Parker ..	4,345	2,663	.. ..	H. p. conc., l.p. triple conc. and 3-core, variou
	A. Gay	100, 200 & 400	50~, 1-ph.	8 Lanc., 10 B. & W., cond., stokers, suphtrs. ..	10 Adamson, 1 Scott-Reavell, Corliss	7 Ferranti, 3 Fowler, 1 Crompton ..	3,600	2,342	Tudor, 30 KW. for 3 hrs. (exciting)	V. r. conc., h. p. in c. i. pipes, l. p. in e.w. paper, laid solid
	H. W. Bowden	100	83~, 1-ph.	Stirling and B. & W.	Willans	E.C.C.	2,830	1,851	.. ..	B.I. & H., h.p. twin, l.p. conc. .. ..
	H. W. Miller ..	200	Direct ..	10 B. & W.	12 Willans	12 Siemens	5,800*	3,467	Tudor and Accumulator Industries, max. dis. 800 KW.	Henley, Callender, B.I. & H. & bare copper; v. mains from Wood Lane, B.I. & H. ppr.,
	H. W. Miller, G. Schultz	90	45~, 3-ph.	8 B. & W., stokers, econ., thermal storage, cond.	7 Willans, 1 Parsons turbine ..	7 Oerlikon, 1 Parsons	4,400	2,838.6	Hart, 15 KW. for 3 hrs. (exc.)	B.I. & H. 3 core, ppr., lead. covd. in ducts
	H. W. Sprunt ..	240	50~, 1-ph.	11 B. & W., 2 Stirling, suphtrs., clg. tr., cond., econ.	4 Ferranti, 1 Yates & Thom ..	4 Ferranti, 1 B.T.H.	3,000	2,634*	.. ..	B.I. & H. conc., ppr., lead covd. .. ..
	G. W. Partridge	100 & 200	88~, 1-ph.	12 Paxman, 17 B. & W	2 Hick-Hargreaves, 3 Plenty, 2 Allen, 1 Willans 1,000 KW., 2 Ferranti	8 Ferranti, 2 Dick Kerr	9,750	5,020	.. ..	B.I. & H., Siemens, Fowler .. .. ..
	F. A. Wilkinson	..	..	Undertaking purchased from Metropolitan Electric Supply Co. on 5th July, 1904; Company continues to supply under agreement, pending completion of Corporation Generating Station.						
	G. Schultz ..	230	Direct ..	4 B. & W.	4 Willans	1 Siemens, 5 Crompton	600*	1,400	Tudor, 3,000 amp.	Bare copper, & B.I. & H. paper, lead covd. Helens diatrine
	J. S. Highfield ..	100 & 200 A.C., 200 D.C.	60~, 1-ph., & direct	69 B. & W., 4 Davey Paxman, 13 Fraser, stokers, cond., 4 clg. trs.	16 Willans, 5 Westinghouse, 10 Parsons turbines, 2 Sulzer	7 Elwell-Parker, 2 Latimer-Clarke, Siemens, 6 Johnson & Phillips, 10 Parsons, 5 Westinghouse, 2 Kolben	19,030	14,596	Acc. Industries, 960 KW.; E.P.S., 2,520 KW.; Chloride, 900 KW.	B.I. & H. fdrs., conc. & triple conc. ppr.; S Henley, B.I. & H. dist. v.r. and ppr.
	.. .. ..	230 & 460	Direct ..	6 B. & W., suphtrs., stokers, cond.	2 Bellias, 2 Willans, 2 Parsons turbines	4 Mather & Platt D.C., 2 Peebles A.C.	3,400	1,224	Hart, max. dis. 180 KW. ..	B.I. & H. 6-core fdrs., 5-core dist., solid in tr
	S. T. Dobson	107 & 214	Direct ..	20 Economic, 8 loco., 2 B. & W.	17 Willans	17 Siemens	8,240*	4,936*	E. P. S., max. dis. 220 KW. ..	Bare cpr., insd. cables in ducts, and armd.
	S. W. Baynes ..	110 220 & 440	Direct* ..	10 B. & W., 5 Lanc., 5 dryback marine	18 Willans, 3 Bellias, 1 Peache, 3 Browett-Lindley	10 Kapp, 2 Latimer Clarke, 4 Siemens, 10 Crompton 1 A. E. G., D.C.; 2 A. E. G., A.C.	6,800	3,198	.. ..	Fibre, lead covd., armd., v.r. arc cables, Callender and others
	C. N. Russell ..	150	Direct ..	8 B. & W., 5 dryback marine, destructor ..	6 Willans, 2 Bellias	9 E. C. C.	1,455	1,460	Pritchetts & Gold, 60 KW. for 6 hrs.	Glover, Henley, B.I. & H. .. .. ..
	E. Ridley ..	100 & 200	Direct ..	5 Paxman Economic	3 Paxman, 2 Bellias	4 E. C. C., 1 Parker	985	706	Chloride, max. dis. 157 KW. ..	Bare cpr. and Callender v. bitumen ..
	D. M. Kinghorn	220 & 440	Direct ..	8 B. & W., stokers, econ.	5 Willans	4 Johnson & Phillips, 1 Siemens ..	1,912	535	Pritchetts & Gold, 22 KW. for 6 hrs.	Lead covd. conc., B.I. & H. .. .. ..
	W. C. P. Tapper	240 & 480	Direct ..	6 B. & W., an 1 2 do. marine; also 6 B. & W. with Manlove Alliott 12-cell dest.	6 Willans, 1 Parsons Turbine ..	5 Mather & Platt, 1 Dick Kerr, 2 Parsons	2,720	1,684	Tudor, max. dis. 100 KW. ..	B.I. & H., St. Helens and Henley, ppr. lead c single, dist. single and triple conc.
	J. F. Jones ..	100	Direct ..	5 Hornsby water-tube, 1 B. & W.	1 Willans, 2 Hornsby, 3 Bellias ..	E.C.C.	935	609	E.P.S., 135 KW. for 3½ hrs. ..	Conc. single lead covd. ppr., v. b.t. & v.r., pipes, & solid; B.I. & H., Callender, Henley
	C. P. Sparks ..	235	50~, 2-ph.	10 B. & W., ch. grate stokers, suphtrs., econ., cond.	11 Brush Universal, 2 Yates & Thom, 2 B. T.-H.	11 Mordey	4,900	3,142	.. ..	H. p. & c. h. p., v.r. armd., & ppr lead covd. l.p. bit. fibre & ppr. lead covd. armd. conc.
	A. B. W. Kennedy	200 & 400	Direct ..	26 Marine dryback, 17 B. & W.	43 Willans	43, various makers*	12,484*	8,125	.. ..	Bare cpr. in ducts, and Callender, in Callende casing and fibre pipes
	A. B. W. Kennedy, S. T. Dobson*	6000	42~, 3-ph.	10 Morrin Climax w. t. vertical)	9 Willans and 1 Bellias	6 Oerlikon and 1 A. E. G.	2,600	4,973	.. ..	Callender 3 core, ppr. lead covd. armd., laid iron troughs
	J. B. Mitchell ..	210 & 420*	Direct* ..	4 Paxman Economic, 4 loco., cond. (Woolwich) 4 B. & W., 12-cell Meldrum dest. (Plumstead)	4 Parsons turbines, 1 Allen, 1 Bumsted-Chandler (Woolwich) 5 Willans (Plumstead)	4 Parsons, 1 Allen, 1 Easton Anderson & Goolden (Woolwich) 6 Brit. Westinghouse (Plumstead)	1,736	737	.. ..	Callender, triple conc. fdrs. armd. direct, 3-c armd. direct, & v. bit solid
	W. H. Patchell	110 & 220	Direct ..	2 Marine, 14 Hornsby water tube, suphtrs., econ., ind. draught, part cond.	14 Bellias	14 Siemens	4,400	4,900	Tudor & Pflueger, max. dis. 1,310 KW.	Siemens, B.I. & H., Callender, and Felten & G., l laid direct, ppr. and bit. laid solid

	£236,701*	102,000	15 arc & Nernst	320=1,104 H.P.		134.7-9			3 and 1							by Mond Gas from Chemical Works	
solid	£417,272	214,784	160 arc	574=3,014 H.P.		287,401 ex. tr.			Lg. 4½, pb. lg. 1, pr. 2 to 1	Flat rate & scale	2,097,902	3.46	1.09	1.56	Purchased from Norwich Electy. Co., Ltd., in 1902.		227
ducts; dist. armd. direct;	£23,000	19,531	20 arc, 115 Nernst	28=111 K.W.		18,000			Lg. 5 & 1½, pb. lg. 5 & 1½, pr. 1½, tr. 1½	Max. demand & flat rate	8,469,921	2.07	.75	1.06	Lighting and traction		228
ader and St. Helens	£8,878	3,100	203 inc.			3,500	4		Lg. 6 & 3, or 5, pr. 3 & 1½, or 2½	Max. demand flat rate & scale	196,028	4.27*	1.564*	2.210*	*Data for 1904		229
conc. fdrs. armd. direct,	£216,882					54,154			Lg. 4, 4½ & 6, pb. lg. contract	Sliding scale & contract							240
it. and v.r. in pipes, solid,	£10,578	5,200		3=12 H.P.			6		Lg. 4 & 1½ pr. 2 to 1½, tr. 1½, pb. lg. 2½	Max. demand flat rate scale	2,869,312	2.58	0.95	1.13	Lg. & tr. Data to March, 1905		241
	£2,000	1,014	23 inc.	1=5 H.P.		1,182	18.2		Lg 7 & 5, pr. 3*	Max. demand & flat rate	96,852	6.2	3.2	4.1	* Minimum of 10s. per H.P. installed		242
nd diatrine, Callender l.p.	£145,401	60,934	32 arc, 48 inc.	42=180 H.P.		65,276	17		Lg. 6½, pb. lg. 4, pr. 3	Flat rate with rebate	12,590	5.9	4½	5.1	Public lighting experimental		243
conc. armd. dist.	£149,000	49,950	91 arc*	18=222 H.P.	102=2,500 H.P.	56,166	8.5		Lg. 6, pr. 3½, pb. lg. 2.3	Flat rate with discount	847,136	5.16	1.67	2.44	Data to December 31st, 1904		244
ll triple conc. lead covd.	£78,155	34,437	238 arc, 69 Nernst	109=879 H.P.		64,709	63.2		Lg. 4, pr. 2½, pb. lg. £25, tr. 2 to 1½	Flat rate & scale	1,757,809	3.8†	1.48†		Lg. & tr. *With rectifiers. †For 1904. Returns for 1905 not available		245
ad covd. ppr. in C.I. pipes,	£81,000	2,050	13 arc, 300 inc.	6=20 H.P.		9,500	50		Lg. 3½, pr. 1, pb. lg. .9d.	Flat rate	1,830,348	1.72	0.65	0.90	Extensions in hand		246
in wood	£89,500	8,198	24 arc, 101 inc.	1=3 H.P.		9,108	24		Lg. 4½, pr. 3, pb. lg. contract	Flat rate and contract	180,909	3.76		2.52			247
conc., dist. 3-core, solid in		2,991	6 arc			2,480			Lg. 7 & 3	Flat rate and contract							248
, v., bit., dist. solid, armd. ltg.		23,651	70 arc, 59 inc.	140 H.P.	40=1,400 H.P.	29,076 ex. tr.			Lg. 4, pb. lg. 1½, pr. 2	Max. demand							249
rs. solid in wood troughs, casing	£48,918	14,839	72 arc, 6 Nernst	23=54 H.P.	28=560 H.P.	31,668			Lg. 4½ & 4, pr. 1½, pb. lg. £12, tr. 2½ to 1½	Flat rate					Tramways not yet running (June 1905)		250
H. and Callender	£126,000	30,600	73 arc		78=1,700 H.P.	74,200			Lg. 4½, pr. 3, tr. 2.5	Flat rate and scale	445,728	3.02	1.60	1.88	Lg. and tr.		251
armd.	£11,412	6,612	6 arc, 1 Nernst	7=11 H.P.		7,015	10		Lg. 6, pb. lg. 4*, pr. 3	Flat rate	1,279,743	3.28	1.22	1.61	Lighting and traction		252
	£55,000		40 arc	10 H.P.	24=888 H.P.				Lg. & pr. 6 & 1½, pb. lg. & tr. 1½	2-rate meter	76,926	5.71	1.82	2.52	* Inc. hire & maintenance. Cost of extensions charged to works costs		253
		149,840	264 arc, 146 inc.	152=341 H.P.		163,980			Lg. 4½ pr. 1½, pb. lg. £18 & £3 3s.	Flat rate	2,717,210				Tr. supply commenced Mar. 6/06. Lg. May 1/05. 230 cons. awaiting connec.		254
	£62,876	10,500	23 arc, 277 inc.	21=161 H.P.	8=200 H.P.	87,594	13		Lg. 4, pb. lg. 2, pr. 1, tr. 1 to ½	Flat rate	2,939,590	1.25	.42	.48	Supply to South Lanc. Tramways and B.I. & H.C. works		256
ns-conc.	£182,750	58,779	42 arc			53,410			Lg. 4 & 2, pr. 1½	Max. demand & sl. scale							257
	£23,000	2,465	15						Lg. 8 & 3	Max. demand							258
fdrs. (3 core) and tr. fdrs. olid in Howard troughing		3,000		3=8 H.P.					Lg. 5, pr. 2, tr. 1½	Sliding scale					Lg. & tr. Plant fully loaded for tr., 250-KW. set being installed		259
rs. triple conc. laid solid, d direct									Lg. 7 & 3, pr 2	Max. demand & flat rate							260
riple conc.	£88,712	22,094	108 arc, 418 inc.	3=9 H.P.		22,319	8.4		Lg. 4½, pr. 2 & 1½, pb. lg. £18 & £3½	Flat rate	547,780	Priv. 4.43 Pub. 2.62	1.13	1.66			261
nd armd., also Simplified ystem	£181,257	60,000		209=1,003 H.P.		90,000 approx.	28		Lg. 6 to 3, pr. 3 to 1½	Sliding scale	1,018,000	3.78	1.03	1.62			262
, lead covd., armd.	£21,584	8,778	31 inc.	28=165 H.P.		15,844			Lg. 5½ & 5, pr. 1½ & 1, pb. lg. £3	Flat rate or 2-rate meter	265,717	2.64	1.88	2.22			263
d	£30,000	12,200	4 inc. (7 amp.)	3=14 H.P.		12,600			Lg. 7 & 4, pr. 3	Max. demand and flat rate							264
olid	£22,898	2,100	58 arc	3		3,045			Lg. 6 & 3, or 4½	Max. demand and flat rate							265
ser laid direct by Glover, d Callender solid system H., ppr., lead covd., fdrs. ducts, dist. armd. direct solid	£83,080	42,023 inc. hg.				45,906	20		Lg. 6, pr. 2½	Flat rate	473,771		1.219	1.519			266
	£63,414	20,710		Appx. 50=376 H.P.	102=3,502 H.P.	28,852 exc. tr.	8.40		Lg. 6 & 2, or 4½, pr. 2 to 1, tr. 1½ to 1	Max. demand flat rate & sc.	1,160,593	1.98	.708	1.029	Lg. and tr.		267
	£5,255	1,500	38 Nernst	3=7 H.P.		2,622	25		Lg. 7, pb. lg. 2½, pr. 3	Flat rate	26,808	6.11	3.41	5.26			268
Glover diatrine	£47,905	17,990		29=80 H.P.	60=1,500 H.P.	54,111	5.2		Lg. 4½ to 4, pr. 1½ to 1, tr. 1½	Flat rate	1,227,007	2.02	0.50	0.80	Lg. and traction.		269
direct, lead covd. in pipes	£3,000	56	35 arc, 22 inc.														270
pipes		1,000	14 inc.	1 H.P.		1,050			Lg. 6	Flat rate							271
	£12,000	4,960	70 Nernst			5,300	41		Lg. 6, pb. lg. 4, pr. 3	Flat rate and sliding scale	29,920						272
d solid	£12,000	8,052		11=13½ H.P.		8,592	50		Lg. 5½, pr. 2½ & 3	Flat rate	88,497	5		3.09	Supply from the B.T.H. Co.'s works at 2,000 volts		273
, laid direct	£4,500	5,000				5,000			Lg. 4 & fixed charge, small houses 5	Hopkinson	42,600						274
c.; h.p. fdrs. conc.; dist. dd., direct	£54,530	8,905	50 inc.	22 H.P.		9,945	87		Lg. 7 & 4, or 6, pr. 4 & 1½, or 2½	Max. demand & flat rate	78,505	4.95	3.1	5.1	*Combined with St. H. E. Ltg. Co. 2500 v. for part of St. H. Pb. lg. £2.5 & £2.7		275
c. fdrs., single dist., solid or v.-bit. covd.	£39,005	15,065	34 arc, 58 inc., 109 Nernst	12=80 H.P.		22,694			Lg. 7 & 2, or 5½, pb. lg. & pr. 2½, tr. 2 to 1½	Max. demand & flat rate	589,500	3.6	1.18	1.55	*Energy sold to Tramway Co., max. demand limited to 300 KW.		276
	£6,000	2,000		14 H.P.		2,350			Lg. 5, pr. 2	Flat					New station being erected		277
ld. covd. fdrs. single & tri. conc. & single armd. direct n. wood; B.L. & Helsby and	£127,956	24,496	35 arc, 70 inc.	160=854 H.P.		54,043	20.8		Lg. 4½, pr. 2 & 1, pb. lg. £15, tr. 1.11 & .97	Lg. flat, pr. m.d., tr. scale	2,089,744	1.85	.554	.78	Lighting and traction. Extensions in hand, 500 KW. Willans-Dick Kerr set		278
	£9,000	5,388	2 arc, 9 inc., 6 Nernst	1=2 H.P.		5,507	21		Lg. 6 & 3, pr. 3 & 1¼, pb. lg. 2½	Max. demand & flat rate	41,380	4.66	2.06	3.1			279
single, fdrs. in ducts, dist. conc. in e.-ware pipes conc. armd. direct	£545,887	125,694	116 arc	370=2,980 H.P.	402=11,080 H.P.	444,342	23.4		Lg. 3½*, pb. lg. 1.22, pr. 2 to 1, tr. 1.5	Flat rate & sliding scale	9,002,310	1.782	.49	.66	Lighting and traction. *Alternative, 1s. per 8-C.P. per qr. & 1½d. per unit		280
	£61,795	20,468	35 inc.	36=182 H.P.		23,833	35		Lg. 7, 4 & 2, pr. 4 & 1½	Max. demand	397,611	3.63	1.08	1.46			281
eless; fdrs., l.c. & armd. st., dialite armd. direct	£14,000	7,300		10=20 H.P.		7,678			Lg. 6 & 6½, pr. 4	Flat rate	60,704	5.47	3.67	4.38	Data to Sept. 30th, 1904		282
v. r., tri. conc., ppr. fdrs. d triple conc. ppr. rs., 3 core dist.	£98,866	51,558		30=128 H.P.	36=1,120 H.P.	83,568			Lg. 7 & 3, or 6, pr. 2, tr. 1.3	Max. d. & flat rate with dis.	790,064	3.93	1.42	2.12	Lighting and traction		283
	£52,387	10,019	15 arc, 341 inc., 16 Nernst	18=171/2 H.P.		12,239	21		Ltg. 7 & 4, or 6, pr. 4 & 1½, or 2½	Max. demand and flat rate	179,328	3.6	1.5	2.05			284
		2,698				11,243			Lg. 7 & 2½, pr. 4 & 1½, tr. 2	Max. demand	157,889*				Lg. & tr. * For 9 months		285
lead covd. diatrine conc.,	£804,527 (inc. pur. fm. co.)	240,285		541=3,617 H.P.		339,710	23.4		Lg. 4, pr. 2 to 1 (w. dis. to .6)	Flat rate with discount	4,546,141	2.97	.64	.80	Reduction of costs largely due to use of new turbine station. Data to March 25th, 1905		286
Western Electric, Anchor	£56,220	9,159	40 arc	71=596 H.P.	540 KW.*				Lg. 4½ & 2, pr. 2 & 1, or 1½, tr. 1½, pb. lg. 1½	Max. demand & flat rate	997,100	1.64	‡.684	.840	Lg. & tr. * Tramway max. load. ‡ Pb. lg. not included		287
fdrs. triple conc.	£45,320	17,944	44 arc, 136 inc.	23=70 H.P.		18,834			Lg. 6, 4 & 2, pr. 4 & 2, pb. lg. 3½ & 3	Max. demand	385,027		1.585	1.985			288
d.	£7,000	1,052	16 arc, 105 inc.	1=6 H.P.		1,650			Lg. 6 & 2, or 6, pr. 3	Max. demand and flat rate							289
d solid in C.I. troughing, l., laid direct	£38,982	5,279	97 inc.	5=10½ H.P.		5,697	40		Lg 6, pb. lg. 3, pr. 3 & 2½	Flat rate with dis.	148,158*	4.50	1.93	2.76	*88,518 units sold in bulk to Windsor E. I. Co. at 3.94d. p.u. Data to Dec. 31, 1904		290
, 3-core paper, ld. c., dra n re solid in Doulto troughs Glover, bitumen and ppr.	£179,351	54,969	92 arc, 66 inc., 6 Nernst	40=200 H.P.	50=1,250 H.P.	88,950			Lg. 7 & 2½, pr. 1½	Max. demand & flat rate					Lg. & tr. Tramway Committee holds E. L. prov. order for Smethwick area		291
olid			44 arc.						Lg. 4½, pb. lg. 2½, pr. 3 & 2, tr. 2½	Flat rate	2,174,322	2.83	1.085	1.418	Lighting and traction		292
									Lg. 6 & 3, pr. 2, tr. 1½	Max. demand & flat rate					Lighting and traction		293
nor, conc., lead covd. and pipes and ducts	£188,866	37,875	184 arc, 2 inc., 6 Nernst	29=288 H.P.	46=1,630 H.P.	139,714	34.7		Lg. 6, 4, & 2, pr. 2 & 1½, tr. 1½ to 1½, are £20*	Max. demand	1,783,107	3.04	.74	1.05	Lighting and traction. *Htg. 4 & 2		294
	£151,838	54,909	91 arc, 462 inc.	30 H.P.		59,209	10		Ltg. 7 & 2, or 5, pr. 2, are £22½, inc. £2.6 (2×16)	Max. demand & flat rate	1,385,393	3	.73	1.19			295
lead. covd. and armd.	£23,698	8,619	1 Nernst 35 arc, 100 inc.	22=81½ H.P.		12,051	17		Lg. 4, pr. 1½, pb. lg. arc £15, inc. £3	& scale Flat rate w. dis. & contract	223,212	3.08	1.33	1.85	new one D.C.		345
; dist., 3-core, drawn into	£50,000	16,780	3,000 arc, 200 inc., 120 Nernst	22=80 H.P.		21,100	23.5		Lg. 6, pb. lg. 4.25 & 3.1, pr. 3 w. dis.	Flat rate with discount	340,054						346
gle, Dialite	£30,273	11,821	34 arc, 7 inc. 5 Nernst	11=80 H.P.	20=500 H.P.	26,864			Lg. 6 to 4½, tr. 2 & 1.3, pr. 2½*	Max. demand, scale & flat	303,268	3.12	1.73	2.28	Destructor supplies steam required in daytime. *Pb. lg. £20 and £7½		347
	£44,412	27,052	75 arc	15=37 H.P.		29,107			Lg. 6 & 4, pr. 3½	Max. demand & flat rate							348
triple conc. armd. direct,	£110,964	46,823	67 arc, 3 inc 11 Nernst	146=658 H.P.		63,273	19		Lg. 7 & 1½, or 4½ to 3½, arc £17, pr. 1½ to 1	Max. demand & scale	904,000	2.84	.97	1.51*	*Including public lighting		349
solid	£220,000	50,418	391 arc, 205 Nerns	620 H.P.		73,030	31		Lg. 4, pr. 1½, arc £18	Flat rate with discounts	1,854,920	1.80			Further 750-KW. Parsons turbine on order		350
ine lead covd., fdrs. in	£48,000	6,000	71 arc						Lg. 6 & 3, pr. 2½	Max. demand							351
ucts	£454,854					210,657			Lg. 6 & 3, pr. 3 & 2	Max. demand	3,212,412	4.23	1.33	1.87			352
pr. in iron pipes	£2,093,035	538,189	505 arc	1,995=214,200 8 c.p.		752,380	17.4		Lg. 3.55, pb. lg. 2.47, pr. 1.99	Flat rate, sl. scale, etc.	17,624,110	3.20	0.85	1.43	Data to Dec. 31st, 1904		353
G., paper insd. laid solid	£1,186,631	245,756		2,213 M.P.		301,081 + bulk supply	24.3 + bulk inc.		Lg. 5 to 2, pr. 2½ to 1	Flat rate, sl. scale & cont.	7,351,737	2.56	.95	1.55	Energy supplied in bulk to West End (C.C., W.E. & C. Co.)		354
e & ppr. conc., lead covd. pr. conc.	£1,383,503	375,939		6,054 H.P.		557,589			Lg. 7 & 3, or 6, pr. 2½ w. disc. to 30%	Mx. dem., flat rate & scale	7,181,309	4.12	1.155	1.866	Data mainly to Dec. 31st, 1904; costs & output include Wandsworth, q.v.		355
vd.	£220,000	51,403	274 arc, 40 inc., 8 Nernst	54=640 H.P.		71,645			Lg. 3½, pb. lg.* arc £25, pr. 1	Sliding scale & flat rate	1,835,052	2.45	.99	1.38	*Nernst £4 0s. 4d., inc. £3 10s. 4d. per annum		356
	£328,264	108,891		About 600 KW.		121,533			Lg. 6, pr. 2	Flat & two rate meter		4.24			*Also par. s of Lambeth and Camberwell		357
ric, triple conc. lead covd.	£285,000	20,000	293 arc						Lg. 4, pr. 2	Flat rate					Three boilers fired with refuse. Conns. for 1904		358
nd armd. direct; Western are ducts	£210,994	68,069	223 arc, 63 inc.	180=1,208 H.P.		98,369	9		Lg. 6 & 3*, pr. 1½; arc £30 p.a.	Max. demand*	2,948,633	2.9	1.05	1.37	*Private lighting to be reduced to flat rate 8d. per unit, in Oct., 1905		359
nd 3-core, various makers		212,806	122 arc, 41 Nernst	34=401 H.P.		224,400			Lg. 6 & 2½, pr. 2; arc £28 p.a.	Max. demand and flat rate							360
s, l. p. in e.w. pipes and	£410,000	93,092	490 arc	144=682 H.P.		121,988	39.87		Lg. 7 & 4, or 5, pb. lg. 3½, pr. 2 to 1½	Max. demand & flat rate	3,097,064	3.95	1.68	2.18			361
	£253,987	169,869		9=238 H.P.		176,540			Lg. 5½ to 4, pb. lg. 2½, pr. 2, tr. 2	Flat rate with discounts	2,544,758	4.50	1.22	2.14			362
& bare copper; 3-ph. 5,000 B.L. & H. ppr., lead covd.	£355,144	302,315	44 arc	200 H.P. (about)		303,048	8		Lg. 5 to 3, pb. lg. 2½, pr. 3 to 2	Flat rate with discounts	4,558,176	3.95	1.2	2.06	*Motor gntrs., 3,580 KW.; 1,760 KW. recd. from Wood Lane Joint Works		363
covd. in ducts	£149,519			4,090 KW. (motor-gen.)											Energy supplied in bulk to companies named. Res. engr., C. M. Bennett		364
vd.	£341,268	94,253	80 arc	151=605 H.P.		108,085	17.6		Lg. 7 & 2, or 4½, pr. 2, tr. 1.4	Max. demand & flat rate	9,205,342	1.95	.91	1.07	*L.C.C. temporary plant, 3,000 KW., supplied with steam under contract		365
	£1,022,770	188,000				238,542	8.75		Lg. 6 to 3½, or 6 & 3, pr. 3 to 1½	Sldg. scale & max. demand	10,531,785	2.6	.97	1.21	*Berm'sey, Ch'sea, De'ford, Gr'nwich, So'hwark, parts of C'b'rwell & L'mbeth		366
psper, lead covd., and St.	£224,267	138,532	45 arc	60=120 H.P.		132,182	12		Lg. 5, pb. lg. 2½ to 2, pr 3, 2 & 1½	Flat rate with discounts	1,645,492	4.7	1.08	2.15	*Motor generators, 2,100 KW. Energy in bulk from Wood Lane Joint Works		368
le conc. ppr.; Silvertown, and ppr.	£1,539,592 (Dec., 1904)	881,500	6 arc	2,450 H.P.		946,700 (Mar., 1905)	12		Lg. 6 to 5, pr. 3 & 1½; pb. lg. £30 p.a.	Flat rate, max. dem. & and sl. scale	15,232,889 (Dec., 1904)	4.65	1.4	2.35	Stations at Willesden, 10,000 v., 2-ph.; Whitehall Ct., Rathbone Pl., Manchester Sq., Amberley Rd. Distg. system changing to D.C.		369
dist., solid in troughs	£187,000	31,424	32) arc, 523 inc.	130=1,706 H.P.		79,455	45		Lg. 5 & 3, pb. lg. 1½ pr. 1½	Max. demand & flat rate							370
ts, and armd.	£438,323	277,719	71 arc			278,880	9½		Lg. 6 to 4, pr. 3 to 2, less 3%	Flat rate with discount	7,515,341	3.74	1.27	1.87	*6 Motor-gentrs. 2,900 KW.; energy at 6,000 v 3-ph fr. Cent. Elec. Supply Co.		371
r. arc cables, bare cpr.,	£460,306		451 arc	315 H.P.		244,438			Lg. 6 & 1½, or 4, pb lg. 3, pr. 1	Max. demand & flat rate	4,730,341	3.84	1.39	1.82	*3-phase A.C., 5,000 v., 50 ~ to sub-stations		372
	£190,912		360 arc						Lg. 5 & 2, or 4½, pr. 2	Max. demand & flat rate					High pressure D.C. with transformers 1,100 v. to 150 v.		373
turmen	£121,808	30,111	618 eq. 8 c.p.	258 H.P.		37,944	21.7		Lg. 6 to 3½, pr. 2½ to 1½	Sliding scale	1,201,046	3.06	1.65	2.3	Price charged includes wiring, maintenance, and lamp renewals		374
	£79,570	26,424	90 arc, 251 inc.	26=110 H.P.					Lg. 6, 4, & 2, pr. 2½	Max. demand & flat rate	677,981	3.05	2.00	2.47			375
nley, ppr. lead covd., fdrs. le conc.	£215,267	78,070	374 arc, 2 inc., 112 Nernst	236=1,340 H.P.		123,582	39		Lg. 8 & 1, pr. 1	Max. demand & flat rate	3,425,158	2.11	0.85	1.10			376
v. b.t. & v.r., direct, in Callender, Henley	£116,090	27,045		16=48 H.P.		28,097	91		Lg. 6, pr. 3	Sliding scale	412,540	5.18	2.94	3.86	High pressure D.C. feeders		377
t ppr. lead covd. & armd. vd. armd. conc.	£1,382,598	375,960				557,589			Lg. 7 & 3, or 6, pr. 2½ with dis. to 30%	Max. demand, dat rate & scale	7,181,309	4.12	1.155	1.866	6,000 v. to sub-stations. Data mainly to Dec. 31st, 1904. costs and output includ. Finsbury, q.v.		378
nder, in Callender Webber	£1,015,493		954 arc, also some inc. & N.			711,679	7.48		Lg. 5½ with rebates, pr. 2½ do.	Scale	14,518,764	4	1.17	1.86	* Also motor-genrs. of 4,300 KW., sup. from Central Electric Company.		379
covd. armd., laid solid in	£446,770			6,800 KW. (motor-gen.)					Bulk, 1½	Flat rate	6,214,873	1.75	0.79	0.90	* Res. engrs, W. Partridge, H. P. Gass. Bulk supply to West. & St. James Cos.		380
armd. direct, 3-core dist.	£169 905	41,154	77 arc, 164 inc. 18 Nernst	220 H.P.		51,104			Lg. 7 & 2½, or 4, pr. 2 to 1½	Max demand, flat & scale	744,610				* 200 v., A.C. 50~ 1-ph. for Eltham only.		381
and Felten & G., jute armd. solid	£981,088	309,939	175 arc	3,854 H.P.		409,668 + bulk supply	29.9 + bulk inc.		Lg. 5 to 4, pr. & htg. 3 to 1½	Flat rate, sl. scale & cont.	8,604,109	3.4	1.39	1.74	Energy supplied in bulk City Orders, C. C., W. E. & C. Co.		382